INSTRUCTION MANUAL

SIGNAL GENERATOR

MODEL SG-8

Precision electrical and electronic instruments for measurement

THE SINGER COMPANY • METRICS DIVISION

INSTRUCTION MANUAL

SIGNAL GENERATOR

MODEL SG-8

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IB3001

WARRANTY

THE SINGER COMPANY, METRICS DIVISION, warrants each new instrument to be free from defects in material and workmanship, effective after delivery to the original purchaser as follows:

*Commander** Instruments: Potentiometers, Bridges,
Volt Ratio Boxes and Standard Resistors.....5 years
*Sensitive Research** Electrical Indicating Instruments.....2 years
Other Electrical and Electronic Measuring Instruments.....1 year

Repair or replacement (at our option) without charge (F.O.B. factory) will be effected when our examination satisfactorily indicates that defects are due to workmanship or materials. Electron tubes, semiconductors, batteries, fuzes, lamps, thermoelements, and *RatioTran** potentiometers are excluded from warranty coverage. Warranty returns must first be authorized by the factory.

If the instrument or any portion thereof, has been abused, misused, damaged by accident or negligence, or if any serial number or seal has been removed or altered, the warranty is void.

This warranty is in lieu of all other obligations or liabilities expressed or implied and The Singer Company neither assumes, nor authorizes any person to assume for them, any other liability in connection with sales of instruments manufactured by The Singer Company, Metrics Division.

THE SINGER COMPANY • METRICS DIVISION
915 PEMBROKE STREET, BRIDGEPORT, CONNECTICUT • 3211 S. LA CIENEGA BLVD., LOS ANGELES, CALIFORNIA

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REPAIR AND MAINTENANCE

Instruments should be returned only on prior written authorization from the Singer Representative or the factory(1). Warranty repair will be made upon written request. Please provide the following information in order to expedite our processing of your instrument:

1. Model or Type
2. Serial Number
3. Description of trouble(2)
4. Test instruments used
5. Approximate date instrument was placed in operation
6. Approximate number of hours of use
7. Has maintenance action been previously requested?
8. Other comments

Upon receipt of this information our Service Department will send you service data or shipping instructions. Upon receipt of shipping instructions forward the instrument to the factory prepaid. If requested, an estimate of charges will be made before work begins.

(1) Contact Metrics Division, Bridgeport, Connecticut for *Commander**, *Empire**, *Panoramic**, and *Sensitive Research** instruments. Contact Metrics Division, Los Angeles, California for *Gertsch** instruments.

(2) Include data on symptoms, measurements taken, suspected location of trouble, maintenance action taken, and any other relevant data.

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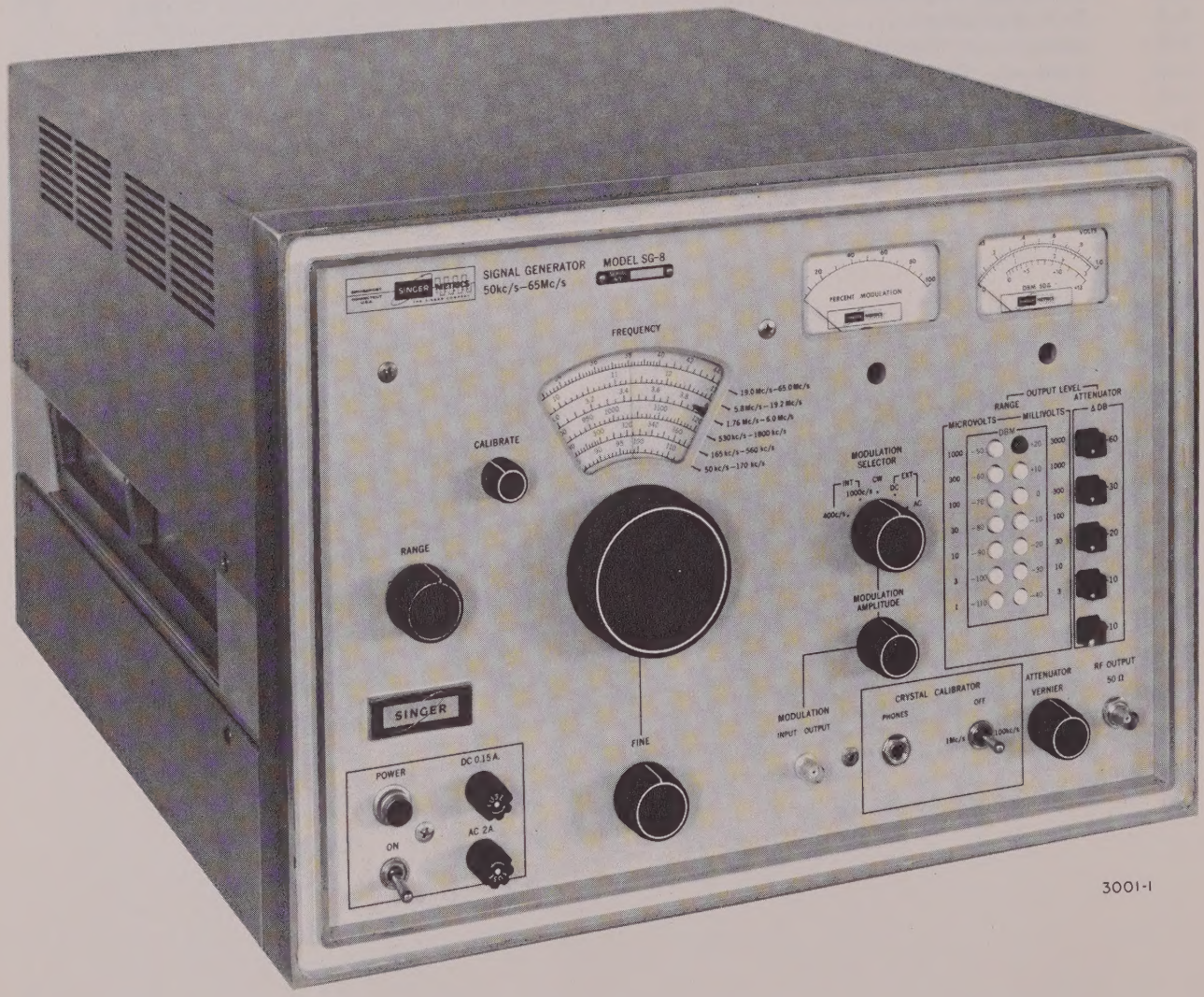


Figure 1-1. Signal Generator, Model SG-8

SECTION 1

INTRODUCTION

1-1. GENERAL.

1-2. This Instruction Manual describes the electrical and physical characteristics, applications, installation, operation, maintenance, and servicing of the Model SG-8 Signal Generator. Section 4 describes the Model SG-8 detailed theory of operation and Section 6 includes a list of all replaceable parts. The overall schematic is included at the end of the manual.

CAUTION

Refer to Section 3 (OPERATION) before attempting to operate equipment. Prolonged use of high gain circuits may shorten tube life and result in unit malfunction.

1-3. APPLICATION.

1-4. This Signal Generator Model SG-8 is used as a source of modulated or unmodulated RF in the frequency range of 50 kc/s to 65 Mc/s with an accuracy as high as ±0.01 percent. The RF output amplitude is continuously adjustable from 0.1 uv to 3 volts with an automatic level control circuit maintaining a constant output regardless of selected frequency or percent of modulation. The units high degree of accuracy as well as versatility lends itself to a multitude of applications. These measurements are: sensitivity, gain, selectivity, image rejection, and bandwidth of IF circuits and receivers; antenna gain and pattern analysis of transmitters and receivers; and noise figure, spurious responses, harmonic distortion, attenuation, impedance, VSWR, and conversion gain of various circuits.

1-5. ACCESSORIES.

1-6. Accessories available for use with the Model SG-8 are:

Item	Part Number	Description
Cable Assembly RG-58/U	AC-109	9-inch length between two UG-88C/U BNC connectors.
Cable Assembly RG-58/U	AC-110	48-inch length between two UC-88C/U BNC connectors.
Output Termination and IRE Dummy Antenna	AT-102	Three outputs are: 1. Dummy antenna-20 db attenuation. 2. 25 ohm termination-0 db attenuation. 3. 5 ohm termination-20 db attenuation.
Fuse Holder	SG-9FH	Protects output attenuator when testing transceivers, should transmitter be turned on while generator is connected to antenna.

1-7. ELECTRICAL CHARACTERISTICS.

1-8. Frequency, calibration, voltage, modulation, and power characteristics are listed in Table 1-1.

TABLE 1-1. ELECTRICAL CHARACTERISTICS

FREQUENCY	
Output Frequency	50 kc/s to 65.0 Mc/s in six overlapping bands.
Frequency Bands	Band 1: 50 kc/s to 170 kc/s Band 2: 165 kc/s to 560 kc/s Band 3: 530 kc/s to 1800 kc/s Band 4: 1.76 Mc/s to 6.0 Mc/s Band 5: 5.8 Mc/s to 19.2 Mc/s Band 6: 19.0 Mc/s to 65.0 Mc/s
Frequency Dial Accuracy	±1 percent over entire frequency range. ±0.01 percent when hairline cursor is reset at 100 kc/s or 1 Mc/s Crystal Calibration intervals.

TABLE 1-1. ELECTRICAL CHARACTERISTICS (Cont).

FREQUENCY (Cont).	
Frequency Stability	≺ 5 c/s or 0.005 percent during a 10 minute interval after initial warm up. (15°C to 35°C ambient) When frequency is changed by dial, unit must be re-stabilized one minute for each 10 percent change of frequency. When frequency is changed by band switching, 10 minutes are required to re-stabilize.
CALIBRATION	
Crystal Calibration Intervals	100 kc/s and 1 Mc/s intervals throughout entire frequency range.
Calibration Accuracy	±0.01 percent at 0° to 50°C (+32° to +122° F).
VOLTAGE	
Output Voltage	0.1 uv to 3.0 volts, continuously adjustable, indicated on RF output meter.
Output Accuracy	±1 db into a 50 ohm resistive load, throughout entire frequency range, at any selected RF output level.
Output Impedance	50 ohms.
VSWR	≺ 1.2
Leakage	Negligible: permits receiver sensitivity measurements down to at least 0.1 microvolts.
Spurious AM	Sidebands are more than 70 db below carrier (down to thermal noise level).
Spurious Harmonic	≺ 3 percent.
Spurious FM	≺ 0.0001 percent or 20 c/s, whichever is greater.
Incidental FM	≺ 0.0025 percent to 65.0 Mc/s ≺ 100 c/s to 4 Mc/s.
Modulation Capabilities	Continuous amplitude modulation to 100 percent, indicated on percent modulation meter.
Modulation Meter Accuracy	±5 percent from 10 to 90 percent modulation.
Internal Modulation Source	Sinusoidal waveforms of 400 or 1000 c/s ±5 percent.
Internal Modulation Output	Approximately 2 volts rms.
Internal Modulation Output Impedance	82 K ohm.
External Modulation Source	DC to 20 kc/s sinusoidal (square up to 3 kc/s, and other complex waveforms may also be inserted).
External Modulation Input Voltage	4.3 volts rms produces 100 percent modulation.

TABLE 1-1. ELECTRICAL CHARACTERISTICS (Cont).

VOLTAGE (Cont).	
External Modulation Input Impedance	Approximately 600 ohms.
Modulation Bandwidth	Up to 20 kc/s maximum, depending upon carrier frequency and percent of modulation.
Modulation Level	± 1/2 db regardless of carrier frequency and output level changes.
Envelope Distortion	≺ 1 percent from 0 to 30 percent of modulation. ≺ 3 percent from 0 to 70 percent of modulation using internal source with RF output of 1 volt or less.
POWER	
AC Power Requirements	115 or 230 VAC ± 10 percent, 50 to 1000 c/s. 170 watts.
CAUTION When using a 230 VAC power source, wiring changes must be made to power transformer T201. Refer to Section 2 for information regarding transformer changes.	

1-9. PHYSICAL CHARACTERISTICS.

1-10. Weights and dimensions of the Model SG-8 are listed as follows:

WEIGHTS

Complete Unit. . . . . 50.5 lb
Shipping Weight. . . . . 64.5 lb

DIMENSIONS

Height. . . . . 14.125 in. (includes 0.625 in. for rubber feet)
Width . . . . . 19.5 in.
Depth . . . . . 21.125 in. (includes 1/2 in. past bezel for knobs)

1-11. TUBE, TRANSISTOR, AND CRYSTAL COMPLEMENT.

1-12. Table 1-2 provides a correlation between circuit reference designator, type, and function of all tubes, transistors, and crystals used in the Model SG-8.

TABLE 1-2. TUBE, TRANSISTOR, AND CRYSTAL COMPLEMENT.

REF. DESIG.	TYPE	FUNCTION
V101A	6AW8A	Crystal calibration mixer
V101B		Crystal calibration oscillator
V102A	12AT7	Percent modulation meter cathode follower
V102B		Crystal calibration audio output amplifier
V103A	12AT7	Modulator audio oscillator
V103B		Modulator audio amplifier
V104A	12AT7	Cathode follower, V105B screen clamp
V104B		Cathode follower, V105A plate clamp
V105A	6AW8A	Differential amplifier
V105B		Differential amplifier
V106A	6AW8A	Cathode follower, V107, V109, and V110 grid bias
V106B		Amplifier, V107 cathode bias
V107A	12AT7	RF oscillator
V107B		RF oscillator
V108	12B4A	Modulator, V109 and V110 cathode bias
V109	6CL6	RF amplifier
V110	6CL6	RF amplifier
V201	12B4A	+310 VDC amplifier, regulator
V202	12B4A	+310 VDC amplifier, regulator
V203	12B4A	+310 VDC amplifier, regulator
V204	12B4A	+310 VDC amplifier, regulator
V205	12B4A	+310 VDC amplifier, regulator
V206A	6AW8A	+310 VDC amplifier, voltage reference
V206B		+310 VDC amplifier, control
V207	12B4A	-200 VDC amplifier, regulator
V208A	6AW8A	-200 VDC amplifier, control cathode follower
V208B		-200 VDC amplifier, control
V209	5651	-200 VDC amplifier, voltage reference
Q101	2N1307	Emitter follower, V105A grid bias
Y101	100 kc/s	Crystal calibration 100 kc/s xtal.
Y102	1 Mc/s	Crystal calibration 1 Mc/s xtal.

SECTION 2

INSTALLATION

2-1. GENERAL.

2-2. Section 2 describes installation procedures for the Model SG-8. These include: unpacking, initial internal and external inspections, mounting, and installation checks.

2-3. UNPACKING AND INITIAL INSPECTION.

2-4. Uncrating and handling of the unit requires only normal precautions applicable to test equipment of this type.

2-5. This instrument has been thoroughly inspected and calibrated prior to shipment.

2-6. EXTERNAL INSPECTION. After removing the unit from the shipping box, carefully inspect the exterior of the instrument for any damage which may have been sustained during shipment. Rotate all controls and/or switches throughout their complete range of rotation, checking for freedom of operation and positive detent locking. Depress the five pushbuttons and verify that they lock in the depressed position. Check for proper unlocking action by depressing the pushbuttons again. They should unlock and return to their initial positions.

2-7. INTERNAL INSPECTION. Remove the top cover from the case by loosening the four screws. The equipment is shipped with all tubes, transistors, crystals, plug-in units, and modules already installed. Check all such components and units for security in their sockets, and wiring for loose connections. After completion of the internal inspection, reinstall the top cover and four screws.

2-8. INSTALLATION PROCEDURES.

2-9. MOUNTING. The Model SG-8 is designed for bench test use or for installation in a standard 19 inch instrument rack. When more than one Model SG-8 or Models SG-9 through SG-14 (Models SG-9 through SG-14 Signal Generators provide continuous frequency coverage to 11.0 Gc/s) is to be used at the same time, units may be stacked one on top of the other.

2-10. The unit becomes rack mountable by removing the main chassis from the cabinet. Slots on the sides of the front panel are provided for mounting the equipment to the front of the rack.

2-11. 230 VAC OPERATION. When delivered from the factory, the Model SG-8 is usually wired for use with a conventional 115 VAC power source. 230 VAC power source operation is possible with minor wiring changes to the primary winding of power transformer T201. See schematic diagram, Figure 2-1, for wiring changes.

CAUTION

If the unit is converted for 230 VAC operation, the 2 ampere fuse (AC 2A) must be replaced with a 1 ampere slow-blow type fuse.

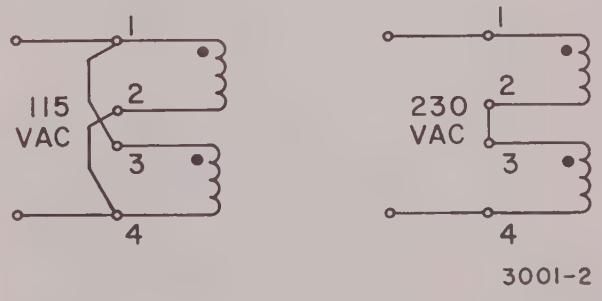


Figure 2-1. T201 Primary Wiring Diagram

2-12. INSTALLATION CHECK.

2-13. After the unit has been initially unpacked, inspected, and located in its operating position, perform installation checks detailed in Table 2-1. This procedure is designed to check the operability of all front panel controls and indicators. Should any indications appear abnormal, refer to Table 5-5.

TABLE 2-1. INSTALLATION CHECK

Step	Procedure	Normal Indication
1.	Set all toggle switches to off position.	POWER and CRYSTAL CALIBRATOR toggle switches set to off position.
2.	Release all pushbuttons.	ATTENUATOR pushbuttons in released (non-depressed) position.
3.	Observe RF output and PERCENT MODULATION meters. WARNING Before applying power to equipment, insure ac power source receptacle is equipped with a ground lug (3-pin connector). Use of conventional 2-pin connector may result in injury to personnel.	Both meters indicate zero; if either meter indicates other than zero, refer to paragraph 5-17.
4.	Insert power plug into ac power source receptacle.	Unit is ready for power application.
5.	Set POWER toggle switch to ON.	POWER indicator lighted red. +10 DBM/1000 MILLIVOLTS RANGE indicator lighted white.
6.	Rotate RANGE selector switch.	Red frequency band indicator on FREQUENCY indicator dial points sequentially to each of the six frequency bands.
7.	Rotate FREQUENCY controls (large FREQUENCY and smaller FREQUENCY FINE controls).	FREQUENCY indicator dial rotates throughout entire range.
8.	Rotate CALIBRATE control.	Hairline cursor on FREQUENCY indicator dial moves.
9.	Insert 2000 ohm impedance headphones into PHONES jack, rotate FREQUENCY indicator dial throughout entire range, and listen for audible beat notes.	No audible beat notes heard.
10.	Set CRYSTAL CALIBRATOR toggle switch to 1 Mc/s and rotate FREQUENCY indicator dial throughout entire range.	Audible beat notes heard at approximately 1 Mc/s intervals.
11.	Set CRYSTAL CALIBRATOR toggle switch to 100 kc/s and rotate FREQUENCY indicator dial throughout entire range.	Audible beat notes heard at approximately 100 kc/s intervals.

Table 2-1. Installation Check (Cont.).

Step	Procedure	Normal Indication
12.	Set CRYSTAL CALIBRATOR toggle switch to OFF and rotate FREQUENCY indicator dial throughout entire range. CAUTION While performing step 13, red +10 Δ DB ATTENUATOR pushbutton should be depressed only momentarily. Depressing this pushbutton increases the gain of the RF amplifier and raises the operation level of the tubes to near maximum. Prolonged use of this high gain factor may shorten tube life and result in unit malfunction.	No audible beat notes heard.
13.	Press ATTENUATOR pushbuttons in following order, observe indication, and release all pushbuttons: +10 Δ DB. All released. -10 Δ DB. -20 Δ DB. -10 and -20 Δ DB. -30 Δ DB. -10 and -30 Δ DB. -20 and -30 Δ DB. -10, -20, and -30 Δ DB. -60 Δ DB. -10 and -60 Δ DB. -20 and -60 Δ DB. -10, -20, and -60 Δ DB. -30 and -60 Δ DB. -10, -30, and -60 Δ DB. -20, -30 and -60 Δ DB. -10, -20, -30, and -60 Δ DB.	The following RANGE indicators lighted while pushbuttons are depressed: +20 DBM/3000 MILLIVOLTS +10 DBM/1000 MILLIVOLTS 0 DBM/300 MILLIVOLTS -10 DBM/100 MILLIVOLTS -20 DBM/30 MILLIVOLTS -20 DBM/30 MILLIVOLTS -30 DBM/10 MILLIVOLTS -40 DBM/3 MILLIVOLTS -50 DBM/1000 MICROVOLTS -50 DBM/1000 MICROVOLTS -60 DBM/300 MICROVOLTS -70 DBM/100 MICROVOLTS -80 DBM/30 MICROVOLTS -80 DBM/30 MICROVOLTS -90 DBM/10 MICROVOLTS -100 DBM/3 MICROVOLTS -110 DBM/1 MICROVOLTS
14.	Rotate ATTENTUATOR VERNIER control fully clockwise and back to fully counterclockwise position.	RF output meter pointer moves from zero to full scale to zero.
15.	Position MODULATION SELECTOR to INT 400 c/s and rotate MODULATION AMPLITUDE control fully clockwise and back to fully counterclockwise position.	PERCENT MODULATION meter pointer moves from zero to full scale to zero.
16.	Position MODULATION SELECTOR to INT 1000 c/s and rotate MODULATION AMPLITUDE control fully clockwise and back to fully counterclockwise position.	PERCENT MODULATION meter pointer moves from zero to full scale to zero.

Table 2-1. Installation Check (Cont.).

Step	Procedure	Normal Indication
17.	Position MODULATION SELECTOR to CW.	PERCENT MODULATION meter indicates zero.
18.	Set POWER toggle switch to off position.	POWER indicator goes out. +10 DBM/1000 MILLIVOLTS RANGE indicator goes out.

SECTION 3

OPERATION

3-1. GENERAL.

3-2. Section 3 provides a functional description of all front panel controls and indicators, and includes a detailed description of a typical operating procedure.

3-3. OPERATING CONTROLS, INDICATORS, AND CONNECTORS. (See Table 3-1 and Figure 3-1.)

3-4. FREQUENCY SELECTION. The frequency of the output is selected by the RANGE selector switch, FREQUENCY, and FREQUENCY FINE controls, and is indicated on the FREQUENCY indicator dial with the aid of the frequency band indicator and hairline cursor.

3-5. The RANGE selector switch is rotated to select individual sets of oscillator and amplifier coils for any one of the following six frequency bands:

Band 1 from 5 kc/s to 170 kc/s
Band 2 from 165 kc/s to 560 kc/s
Band 3 from 530 kc/s to 1800 kc/s
Band 4 from 1.76 Mc/s to 6.0 Mc/s
Band 5 from 5.8 Mc/s to 19.2 Mc/s
Band 6 from 19.0 Mc/s to 65.0 Mc/s

3-6. The individual sets of oscillator and amplifier coils for the frequency bands are overlapping, insuring complete coverage of the frequency range.

3-7. The coils are tuned to the frequency range of the band by internal slugs and trimmer capacitors. The oscillator coils are mounted on a round, insulated turret with gear teeth on its periphery. The gear teeth mesh with matching gear teeth on a similar turret upon which are mounted the applicable amplifier coils. Each coil is wired to a set of contacts on the turret. When the RANGE selector switch is operated, the respective oscillator and amplifier coils are inserted into the circuit, producing the selected frequency output.

3-8. When the RANGE selector switch is rotated and is out of its detent position, biasing voltage is removed from the differential amplifier circuit. This keeps the amplifier tubes from drawing excessive screen current when the turrets, with their applicable oscillator and amplifier coils, are disengaged from their respective plate circuits.

3-9. As the RANGE selector switch is rotated, a red frequency band indicator, on the right side of the FREQUENCY indicator dial, moves up or down, designating the selected frequency band.

3-10. The FREQUENCY control, mounted on a common shaft with the rotating FREQUENCY indicator dial and FREQUENCY FINE control, rotates the indicator dial, indicating the approximate frequency being generated.

3-11. The FREQUENCY FINE control, below the FREQUENCY control, is drive-gear connected to the FREQUENCY indicator dial and permits fine tuning of the frequency band to the exact frequency desired.

3-12. The CALIBRATE control positions the hairline cursor on the FREQUENCY indicator dial. The hairline cursor, on the rear surface of the indicator dial face plate, is mounted very close to the indicator dial, eliminating, as nearly as possible, reading error due to parallax.

3-13. When not using Crystal Calibration, the CALIBRATE control is used to position the hairline cursor in a vertical position. This positioning provides a dial accuracy of ± 1 percent. When Crystal Calibration is in use (refer to paragraph 3-14.), the CALIBRATE control positions the hairline cursor exactly to the nearest 100 kc/s or 1 Mc/s interval.

3-14. CRYSTAL CALIBRATION. For applications requiring a high degree of accuracy, Crystal Calibration is employed. Calibration is provided in 100 kc/s or 1 Mc/s intervals throughout the entire frequency range. The CRYSTAL CALIBRATION toggle switch is used to switch either the 100 kc/s or 1 Mc/s crystals into the crystal oscillator circuit. The beat note technique employed provides an output at the PHONES jack which is the result of the RF output and a harmonic of the calibration crystal being used. Audible beat notes at each interval of calibration are monitored using 2000 ohm impedance headphones at the PHONES jack. The RF output during Crystal Calibration is

accurate within ± 0.01 percent. After calibration has been accomplished, set the CALIBRATE toggle switch to the OFF position; otherwise, the crystal oscillator modulates the RF output.

3-15. OUTPUT ATTENUATION. The RF output level is indicated by the RF output meter. The meter has three scales; two scaled in volts (zero to 1.0 and zero to 3.0 volts rms full scale), and the other in dbm (zero to +13 dbm). ATTENUATOR pushbuttons provide calibrated attenuation of the output in 10 db steps from +10 db to -120 db. Adjacent to the ATTENUATOR pushbuttons are fourteen RANGE indicators which provide a visual indication of the attenuation level in volts and dbm. The ATTENUATOR VERNIER control adjusts the RF output to any level between zero and meter full scale.

3-16. Calibrated power output is obtained when the RF output meter reading is adjusted to the calibration index with the ATTENUATOR VERNIER control. With all of the ATTENUATOR pushbuttons released (non-depressed), and the RF output meter indicating the calibration index, the RF output is a calibrated +10 dbm. (The RF output of +10 dbm corresponds to a power level of 10 milliwatts or a voltage of 0.707 volts rms across a 50 ohm resistive load. Zero dbm is defined as a power level of 1 milliwatt or a voltage of 0.224 volts rms across a 50 ohm resistive load.) During this condition, the +10 DBM/1000 MILLIVOLTS RANGE indicator is lighted, indicating a +10 dbm power output and that the output voltage is read on the 1000 millivolts scale (in this case, 707 millivolts).

3-17. Attenuation of the RF output level from +10 dbm to -120 dbm is accomplished with the use of the four black ATTENUATOR pushbuttons (-10, -20, -30, and -60 Δ DB) and the red ATTENUATOR pushbutton (+10 Δ DB). Depression of the black pushbuttons (any one, combination, or all) results in a corresponding attenuation of the RF output due to the insertion of appropriate attenuation pi-pads into the RF output circuit. Depression of the red pushbutton results in a +10 db gain of the RF output due to a changed amount of feedback in the automatic level control (ALC) circuit.

CAUTION

The red +10 Δ DB ATTENUATOR pushbutton is provided for momentary use only. Depressing this pushbutton results in a change of feedback in the ALC circuit which increases the gain of the RF amplifier and raises the operating level of the tubes to near maximum. Prolonged use of this high gain factor may shorten tube life and result in unit malfunction.

3-18. The fourteen RANGE indicators display the RF output meter full scale range in volts rms and the output power level in dbm when the meter indicates the calibration index. With the meter indicating the calibration index and the red +10 Δ DB ATTENUATOR pushbutton depressed, the red +20 DBM/3000 MILLIVOLTS RANGE indicator illuminates, indicating an RF output of +20 dbm or 2.24 volts rms. The maximum 3.0 volt or approximately +23 dbm output is attained by adjusting the meter pointer to full scale deflection with the ATTENUATOR VERNIER control. When all black ATTENUATOR pushbuttons are depressed, the -110 DBM/1 MICROVOLTS RANGE indicator illuminates, indicating a 1 microvolt full scale deflection and -110 db power level at the calibration index. Adjusting the ATTENUATOR VERNIER control until the meter pointer indicates zero on the DBM scale provides an output of -120 dbm at approximately 0.2 microvolts.

3-19. MODULATION. The use of internal or external amplitude modulation is controlled by the MODULATION SELECTOR switch. This five position switch permits the selection of two internal sinusoidal sources (INT 400 c/s or INT 1000 c/s), continuous wave unmodulated output (CW), or external modulation (EXT DC or EXT AC). The external ac source may be sinusoidal up to 20 kc/s, square, or any other complex waveform.

3-20. The amplitude of the modulation signal (internal or external) is controlled by the MODULATION AMPLITUDE control. The percent of modulation is read directly on the PERCENT MODULATION meter. Amplitude modulation is adjustable from zero to 100 percent, and the selected modulation level is constant within ± 0.5 db.

3-21. The MODULATION INPUT/OUTPUT jack provides a method of feeding external modulation signals into the signal generator circuitry (differential amplifier). A 4.3 volt rms input signal produces 100 percent modulation at modulating frequencies from dc to 20 kc/s. This jack also makes available the internal 400 c/s or 1000 c/s modulation signals when needed for synchronization purposes.

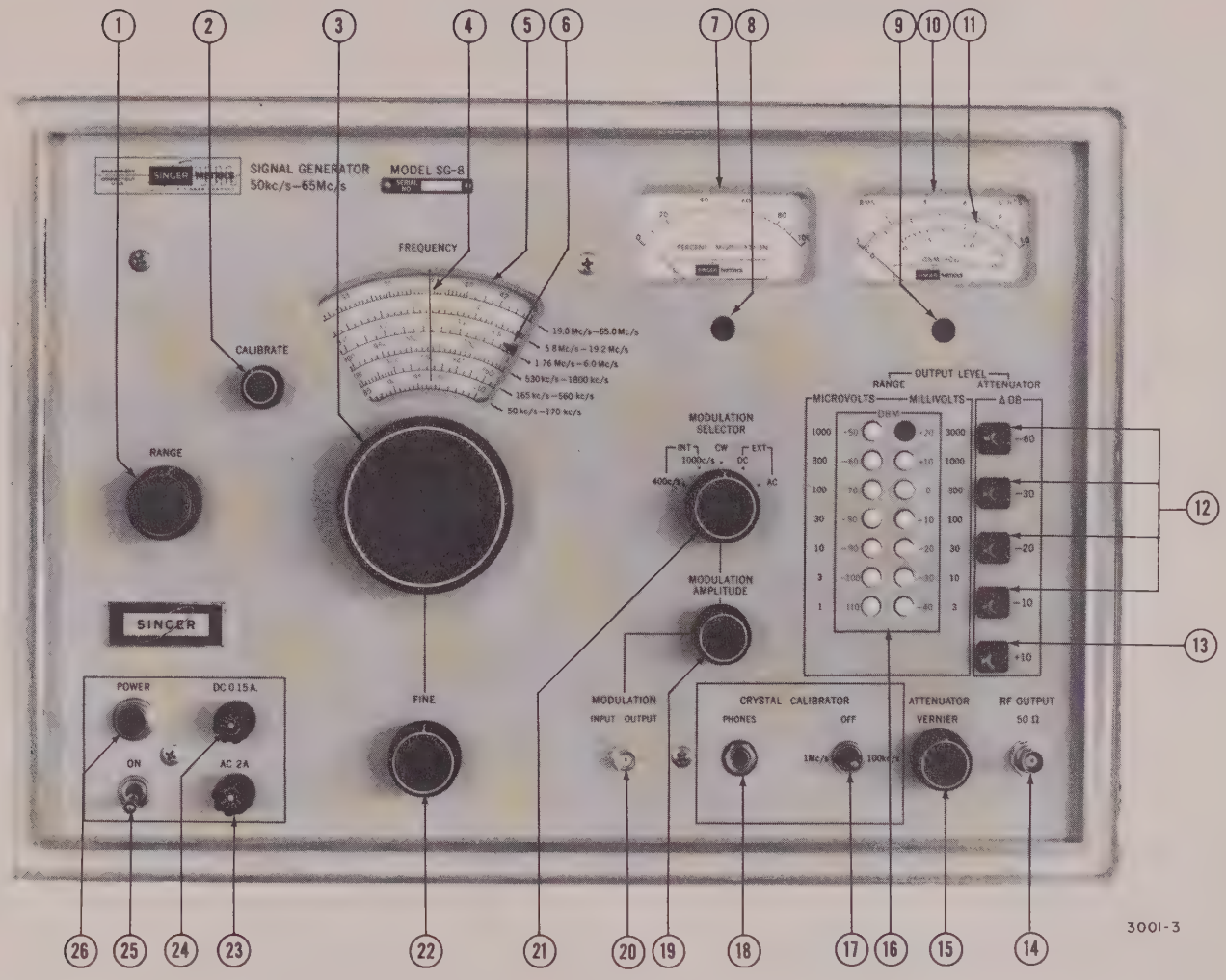


Figure 3-1. Operating Controls, Indicators and Connectors

TABLE 3-1. FRONT PANEL CONTROLS AND INDICATORS.

Index Number (Fig. 3-1)	Nomenclature	Ref. Desig.	Function
1.	RANGE selector switch.	S104	Selects one of six bands of frequency range indicated by position of frequency band indicator (6).
2.	CALIBRATE control.	None	Adjusts FREQUENCY indicator dial (4) hairline cursor (5) to indicate precise frequency being generated during Crystal Calibration.
3.	FREQUENCY control.	None	Provides coarse tuning of frequency output; rotates FREQUENCY indicator dial (4) to indicate selected frequency.

TABLE 3-1. FRONT PANEL CONTROLS AND INDICATORS (CONT).

Index Number (Fig. 3-1)	Nomenclature	Ref. Desig.	Function
4.	FREQUENCY indicator dial.	None	Indicates selected frequency band by position of frequency band indicator (6) controlled by RANGE selector switch (1); indicates selected frequency by position of hairline cursor (5).
5.	Hairline cursor.	None	Indicates precise frequency being generated during Crystal Calibration.
6.	Frequency band indicator.	None	Indicates selected frequency band.
7.	PERCENT MODULATION meter.	M101	Indicates percent of amplitude modulation of RF output.
8.	PERCENT MODULATION meter adjustment screw.	None	Adjusts PERCENT MODULATION meter (7) to mechanical zero.
9.	RF output meter adjustment screw.	None	Adjusts RF output meter (10) to mechanical zero.
10.	RF output meter.	M102	Indicates RF output in volts rms and dbm (0 dbm is 1 milliwatt or 0.224 volts rms into 50 ohms).
11.	Calibration index.	None	Indicates an RF output of +20 dbm to -110 dbm in 10 db intervals.
12.	ATTENUATOR pushbuttons (-10, -20, -30, and -60 DB).	S301 through S304	Inserts 10, 20, 30 and/or 60 db pi-pads in any selected combination to produce desired attenuation of RF output.
13.	ATTENUATOR pushbutton (+10 DB).	S305	Changes amount of feedback in automatic level control (ALC) circuit to increase RF output by +10 db.
14.	RF OUTPUT 50 Ω jack.	J301	Provides RF output connection for a coaxial output cable; mates with UG-88 A/B/C/D connector.
15.	ATTENUATOR VERNIER control.	R129	Controls fine attenuation of RF output between the 10 db intervals selected by ATTENUATOR pushbuttons (12 and 13); returns pointer of RF output meter (10) to red calibration index (11).

TABLE 3-1. FRONT PANEL CONTROLS AND INDICATORS (CONT).

Index Number (Fig. 3-1)	Nomenclature	Ref. Desig.	Function
16.	RANGE indicators.	DS301 through DS314	Illuminate in accordance with a switching matrix controlled by ATTENUATOR pushbuttons (12 and 13) to indicate attenuation in volts and dbm.
17.	CRYSTAL CALIBRATION toggle switch (1 Mc/s - OFF-100 kc/s).	S101	Selects 100 kc/s or 1 Mc/s calibrating crystal or removes crystals from circuit.
18.	PHONES jack.	J101	Provides audible beat note output to high impedance (over 2000 ohms) headphones during Crystal Calibration.
19.	MODULATION AMPLITUDE control.	R117	Controls percent of modulation as indicated on PERCENT MODULATION meter (7).
20.	MODULATION INPUT/ OUTPUT jack.	J102	Input receptacle for 400 c/s or 1000 c/s internal modulation.
21.	MODULATION SELECTOR switch (INT 400 c/s - INT 1000 c/s - CW - EXT DC - EXT AC).	S102	Selects modulation mode.
22.	FREQUENCY FINE control.	None	Provides fine tuning of frequency output; rotates FREQUENCY indicator dial (4) to indicate selected frequency.
23.	DC 0.15A. fuse.	F101	Provides overload protection for RF B+ circuit.
24.	AC 2A. fuse.	F201	Provides overload protection for AC input power circuit.
25.	POWER toggle switch.	S201	Controls on-off condition of unit.
26.	POWER indicator.	DS201	Indicates on-off condition of unit.

3-22. OPERATING PROCEDURES.

3-23. An operation example encompassing the use of all front panel controls and indicators is provided in Table 3-2. The frequency of 10.7 Mc/s is chosen for use in the example. The table is divided into the following procedures: Power Turn On, Frequency Adjustment, Crystal Calibration, Output Attenuation, Modulation, and Power Turn Off. Power Turn On and Turn Off procedures are applicable for each time the unit is operated. To attain an RF output with ± 1 percent accuracy, perform the Frequency Adjustment procedures (steps 6 through 11) setting the FREQUENCY controls to the desired frequency. To attain an RF output with ± 0.01 percent accuracy, perform the Frequency Adjustment procedures setting the FREQUENCY controls to the nearest 1 Mc/s integral of the desired output, then perform the Crystal Calibration procedures (steps 11 through 20) to attain the final output. Output Attenuation and Modulation procedures are described in a general manner and are performed as applicable.

TABLE 3-2. OPERATING PROCEDURES

Step	Procedure	Normal Indication
	POWER TURN ON	
1.	Set all toggle switches to off position.	POWER and CRYSTAL CALIBRATOR toggle switches set to off position.
2.	Release all pushbuttons.	ATTENUATOR pushbuttons in released (non-depressed) position.
3.	Insert power plug into ac power source receptacle.	Unit is ready for power application.
4.	Set POWER toggle switch to ON.	POWER indicator lighted red. +10 DBM/1000 MILLIVOLTS RANGE indicator lighted white.
5.	Allow unit to warm up for at least 15 minutes.	Unit is ready for operation.
	FREQUENCY ADJUSTMENT	
	NOTE Steps 6 through 10 adjust the RF output to 11 Mc/s (the nearest 1 Mc/s integral to 10.7 Mc/s), such that Crystal Calibration may be used to attain the final 10.7 Mc/s output. If the accuracy of Crystal Calibration is not desired, perform steps 6 through 10 adjusting the output to 10.7 Mc/s instead of 11 Mc/s.	
6.	Position MODULATION SELECTOR switch to CW.	PERCENT MODULATION meter indicates zero.
7.	Rotate RANGE selector switch to select band 5 (5.8 Mc/s to 19.2 Mc/s) frequency range	Frequency band indicator points to second band from the top of the FREQUENCY indicator dial.
8.	Rotate CALIBRATE control to adjust hairline cursor to vertical position.	Hairline cursor positioned vertically with reference to FREQUENCY indicator dial.
9.	Rotate FREQUENCY control to adjust FREQUENCY indicator dial to approximately 11 Mc/s.	Hairline cursor indicates approximately 11 Mc/s on FREQUENCY indicator dial.

TABLE 3-2. OPERATING PROCEDURES (CONT).

Step	Procedure	Normal Indication
	FREQUENCY ADJUSTMENT (Cont).	
10.	Rotate FREQUENCY FINE control to adjust FREQUENCY indicator dial to exactly 11 Mc/s. NOTE The RF output is now 11 Mc/s ± 1 percent. For a ± 0.01 percent accuracy of 10.7 Mc/s output, perform Crystal Calibration procedures (steps 11 through 20).	Hairline cursor indicates exactly 11 Mc/s on FREQUENCY indicator dial.
	CRYSTAL CALIBRATION	
11.	Insert connector of high impedance headphones (at least 2000 ohm) into PHONES jack.	Audible beat notes may be monitored by operator using headphones during Crystal Calibration.
12.	Set CRYSTAL CALIBRATOR toggle switch to 1 Mc/s.	RF output being modulated by 1 Mc/s.
13.	Vary FREQUENCY FINE control around setting made in step 10 to obtain zero beat.	Audible beat note heard with headphones. FREQUENCY indicator dial moves correspondingly as FREQUENCY FINE control is varied.
14.	Rotate CALIBRATE control to readjust hairline cursor to 11 Mc/s.	Hairline cursor indicates exactly 11 Mc/s on FREQUENCY indicator dial.
15.	Set CRYSTAL CALIBRATOR toggle switch to 100 kc/s.	Audible beat note heard with headphones, proceed to step 17; if beat note is not heard, perform step 16.
16.	Vary FREQUENCY FINE control around setting made in step 13 to obtain zero beat.	Audible beat note heard with headphones. FREQUENCY indicator dial moves correspondingly . FREQUENCY FINE control is varied.
17.	Rotate CALIBRATE control to readjust hairline cursor to 11 Mc/s.	Hairline cursor indicates exactly 11 Mc/s on FREQUENCY indicator dial.
18.	Rotate FREQUENCY FINE control to tune down band until third beat note is reached.	Three audible beat notes heard with headphones.
19.	Rotate CALIBRATE control to adjust hairline cursor to 10.7 Mc/s.	Hairline cursor indicates exactly 10.7 Mc/s on FREQUENCY indicator dial.

TABLE 3-2. OPERATING PROCEDURES (CONT).

Step	Procedures	Normal Indication
	CRYSTAL CALIBRATION (Cont).	
20.	Set CRYSTAL CALIBRATOR toggle switch to OFF and disconnect headphones. NOTE Crystal Calibration procedures adjust the RF output to 100 kc/s intervals. Should a finer tuning be required, rotate FREQUENCY FINE control to desired frequency on FREQUENCY indicator dial.	10.7 Mc/s ± 0.01 percent available at RF OUTPUT jack.
	OUTPUT ATTENUATION	
	CAUTION The red +10 Δ DB ATTENUATOR pushbutton is provided for momentary use only. Prolonged use of this pushbutton may result in unit malfunction.	
21.	Press following ATTENUATOR pushbuttons to select desired range of output attenuation:	Following RANGE indicators lighted, indicated power level at calibration index and selected full scale meter range:
	+10 Δ DB.	+20 DBM/3000 MILLIVOLTS
	All released.	+10 DBM/1000 MILLIVOLTS
	-10 Δ DB.	0 DBM/300 MILLIVOLTS
	-20 Δ DB.	-10 DBM/100 MILLIVOLTS
	-10 and -20 Δ DB.	-20 DBM/30 MILLIVOLTS
	-30 Δ DB.	-20 DBM/30 MILLIVOLTS
	-10 and -30 Δ DB.	-30 DBM/10 MILLIVOLTS
	-20 and -30 Δ DB.	-40 DBM/3 MILLIVOLTS
	-10, -20, and -30 Δ DB.	-50 DBM/1000 MICROVOLTS
	-60Δ DB.	-50 DBM/1000 MICROVOLTS
	-10 and -60 Δ DB.	-60 DBM/3000 MICROVOLTS
	-20 and -60 Δ DB.	-70 DBM/100 MICROVOLTS
	-10, -20, and -60Δ DB.	-80 DBM/30 MICROVOLTS
	-30 and -60Δ DB.	-80 DBM/30 MICROVOLTS
	-10, -30, and -60Δ DB.	-90 DBM/10 MICROVOLTS
	-20, -30, and -60Δ DB.	-100 DBM/3 MICROVOLTS
	-10, -20, -30, and -60 Δ DB.	-110 DBM/1 MICROVOLTS
	NOTE For attenuation levels below -80 dbm, use double braid shielded cable RG-55U.	
22.	Rotate ATTENUATOR VERNIER control to adjust RF output voltage and power level.	RF output meter indicates RF output voltage and power level.

TABLE 3-2. OPERATING PROCEDURES (CONT).

Step	Procedures	Normal Indication
	MODULATION	
	NOTE Perform steps 23 through 26 for internal modulation; steps 27 through 30 for external modulation.	
23.	Position MODULATION SELECTOR switch to CW.	PERCENT MODULATION meter indicates zero modulation.
24.	Connect output cable to MODULATION INPUT OUTPUT jack.	Unit is ready for internal modulation.
25.	Position MODULATION SELECTOR switch to INT 400 c/s or INT 1000 c/s as required	400 c/s or 1000 c/s modulation sinusoidal waveform available at MODULATION INPUT/OUTPUT jack.
26.	Rotate MODULATION AMPLITUDE control to adjust desired percent of modulation.	PERCENT MODULATION meter indicates percent of modulation.
27.	Position MODULATION SELECTOR switch to CW.	PERCENT MODULATION meter indicates zero modulation.
28.	Connect external source to MODULATION INPUT/OUTPUT jack.	Unit is ready for external modulation.
29.	Position MODULATION SELECTOR switch to EXT DC or EXT AC as applicable.	External source is modulating RF output.
30.	Rotate MODULATION AMPLITUDE control to adjust desired percent of modulation.	PERCENT MODULATION meter indicates percent of modulation.
	POWER TURN OFF	
31.	Release all ATTENUATOR pushbuttons.	+10 DBM/1000 MILLIVOLTS RANGE indicator lighted white.
32.	Set CRYSTAL CALIBRATOR toggle switch to OFF.	RF output not being modulated by Crystal Calibration Xtals.
33.	Position MODULATION SELECTOR switch to CW.	PERCENT MODULATION meter indicates zero modulation.
34.	Set POWER toggle switch to off position.	POWER indicator goes out. +10 DBM/1000 MILLIVOLTS RANGE indicator goes out.

SECTION 4

THEORY OF OPERATION

4-1. GENERAL.

4-2. This section describes the theory of operation of the Signal Generator. The unit is discussed on a block diagram level. Figure 4-1 is a simplified block diagram of the overall unit, and figures 4-2 and 4-3 are detailed block diagrams. The complete schematic diagram is included at the end of the manual.

4-3. The circuitry consists of five major sections (See Figure 4-1): RF Oscillator and Amplifier, Output Attenuator, Crystal Calibrator, Modulator, and Power Supply. The 50 kc/s to 65.0 Mc/s RF output, divided into six bands selectable by the RANGE selector switch, is generated by the RF Oscillator and is determined by the FREQUENCY controls. The amplified RF is fed to the Output Attenuator, RF Output Meter, and Crystal Calibrator. The RF Output Meter displays the output voltage and power level. The Output Attenuator, controlled by the ATTENUATOR pushbuttons, determines the RF output level. The Crystal Calibrator mixes the RF output with harmonics of the 100 kc/s or 1 Mc/s crystals and provides an audible beat note output. When modulation is used, the 400 c/s or 1000 c/s sinusoidal from the internal Audio Oscillator, or the external DC or AC modulating voltage, is fed through the MODULATION SELECTOR switch to the Modulator and PERCENT MODULATION Meter. The Modulator controls the gain of the RF Amplifier and the meter displays the percent of amplitude modulation. Two conventional regulated power supplies are used; 310 VDC positive and 200 VDC negative.

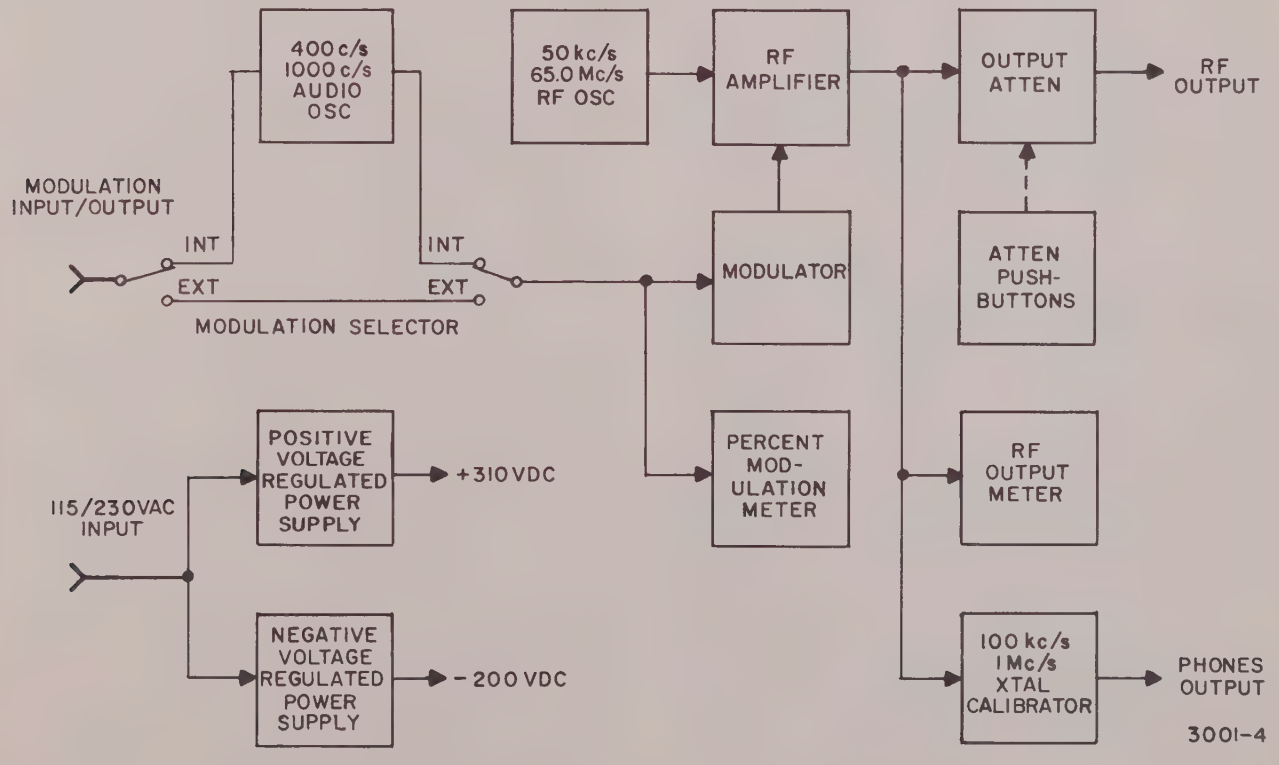


Figure 4-1. Simplified Block Diagram, Signal Generator

4-4. BLOCK DIAGRAM ANALYSIS.

4-5. RF OSCILLATOR (See Figure 4-2). RF oscillator V107 is a dual triode connected in a push pull tuned plate configuration. The entire frequency range from 50 kc/s to 65.0 Mc/s is covered in six overlapping bands by means of switchable RF oscillator plate circuit transformer coils Z401 and RF amplifier plate circuit transformer coils Z402. RANGE selector switch S104 selects one of the six frequency bands. The FREQUENCY controls provide fine tuning of the individual coils. Cathode bias is controlled by V106B. A small amount of the RF at the grid of the oscillator is detected by diode CR104 and applied to the control grid of V106B as a DC voltage proportional to the oscillator signal amplitude. A change in this amplitude, appears as a proportional change in V106B grid voltage. This changes the cathode bias and current of the oscillator in a direction to correct the RF oscillator output level to near its original value. V106B acts as a variable cathode bias resistor. Oscillation signal amplitude is established by Oscillation Level Adjustment R140 by setting the DC reference level of the grid of V106B. The total level on this grid is the fixed DC level from potentiometer R140 and the rectified oscillator output. Stability of the oscillator is enhanced by use of direct coupling to the grids of RF amplifiers V109 and V110, and by use of a DC voltage that has been rectified and filtered for the filaments of V104 through V110. Fixed DC grid bias for RF oscillator V107, and RF amplifiers V109 and V110, is provided by cathode follower V106A.

4-6. RF AMPLIFIERS. The RF amplifiers V109 and V110 are connected in a push pull tuned plate configuration. The method of obtaining cathode bias is similar to the RF oscillator cathode bias circuit; the difference being the source of cathode voltage, V108, the modulator (cathode bias control). Cathode bias for this stage is derived from the automatic level control (ALC) circuit (refer to paragraph 4-8). ALC voltage amplitude is directly proportional to the amplifiers output signal amplitude. Any change in output level results in a corresponding change in V108 grid bias, maintaining a constant RF output amplitude. When modulation is used, V108 functions as a modulator, causing the amplifiers cathode current to vary with the modulating signal. The RF amplifier output is applied to ALC peak detector CR105 and CR106, and to low pass filter Z501.

4-7. ATTENUATOR. Attenuator Z301 consists of a four section pi-network. The input to the attenuator is from R160 through low pass filter Z501. R160 is a 50 ohm resistor required to obtain the desired 50 ohm output impedance. The low pass filter is designed to suppress any harmonics generated in the RF oscillator and RF amplifier circuits. Any attenuation (0 to -120 db in 10 db steps) may be selected by ATTENUATOR pushbuttons S301 through S305. The four brown pushbuttons S301 through S304 operate microswitches S306 through S313, inserting the required pi-pads for the selected attenuation. The fifth (red) pushbutton S305 increases the gain of the ALC circuit (refer to paragraph 4-10) by +10 db. RANGE indicators DS301 through DS314 illuminate in accordance with a switching matrix controlled by ATTENUATOR pushbuttons S301 through S305, indicating the value of attenuation selected. The attenuator provides an output to crystal calibration mixer V101A (refer to paragraph 4-18). The RF output is brought out to coaxial receptacle RF OUTPUT jack J301.

4-8. AUTOMATIC LEVEL CONTROL (ALC). The ALC circuit maintains a constant RF amplifier signal output for all operating frequencies. A +10 db gain in the RF output is accomplished by changing the reference level of the ALC voltage. The ALC circuit also supplies its detected RF output to RF output meter M102.

4-9. The full value of RF output from RF amplifier transformer coils Z402 is detected by ALC peak detector, CR105 and CR106 connected in series. The detector circuit response time is a function of frequency. RANGE selector switch S104 selects the proper detector RC circuit capacitance as the frequency bands are changed. The detected signal is fed through the +10 db gain voltage dividing circuit to the grid of differential amplifier V105B and to RF output meter M102.

4-10. When the red +10 DB ATTENUATOR pushbutton S305 is pressed, relay K101 becomes energized and causes removal of R158 and insertion of R159 into the +10 db gain circuit. This results in a decrease in DC signal level at the grid of V105B and causes a net increase in RF signal amplitude of +10 db.

4-11. RF output meter M102 circuit contains filter components that remove the modulation component in the detected RF output. Output Meter Set R157 adjusts the meter for full scale deflection.

4-12. Operation of the ALC circuit is analyzed with no modulation applied to the grid of differential amplifier V105A. The grid of V105A is therefore at a level established by the ATTENUATOR VERNIER control R129. The grid of V105B is at a DC reference level (ALC

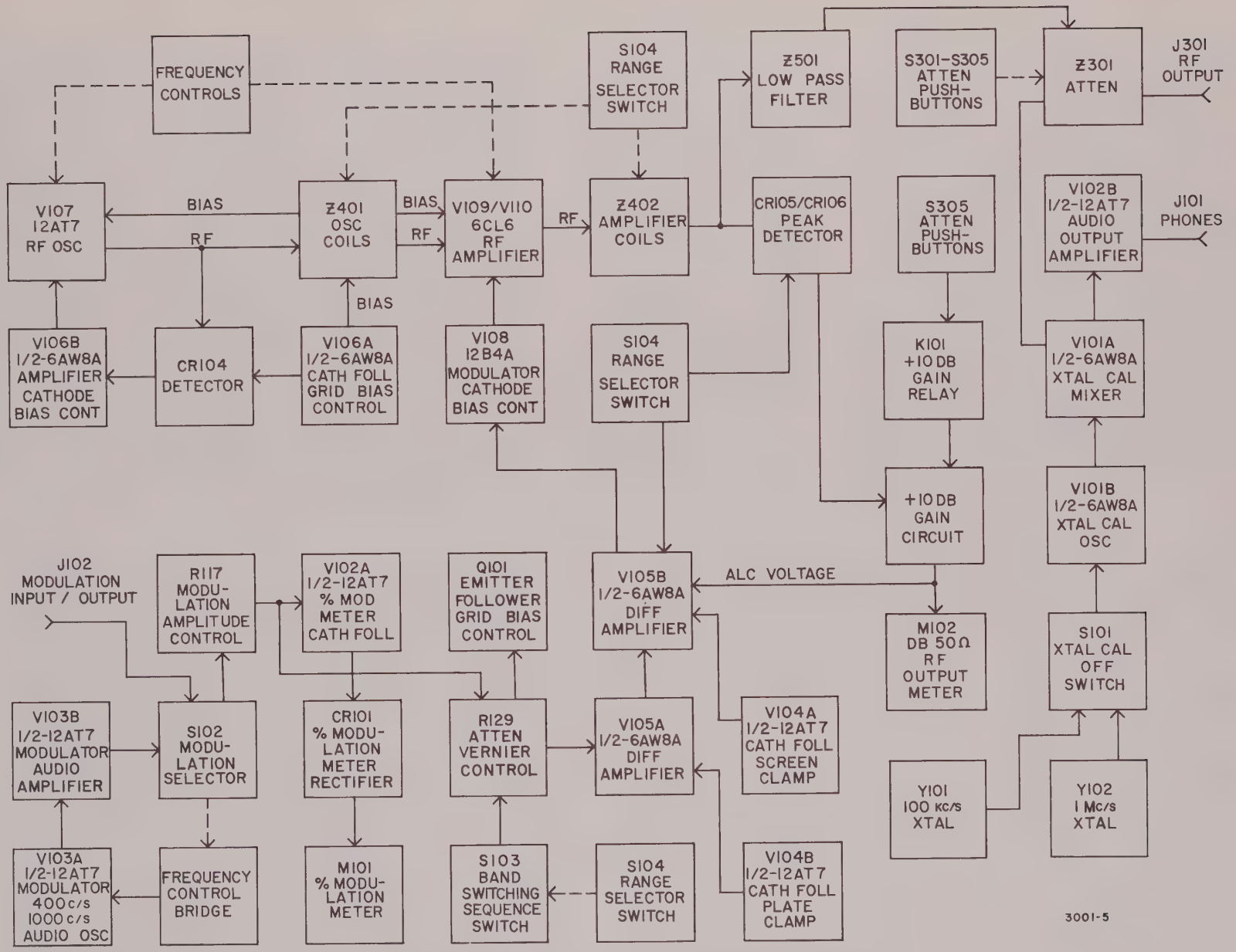


Figure 4-2. Detailed Block Diagram, Signal Generator

voltage) which is proportional to the detected RF output. A momentary change in RF output signal amplitude causes a proportional change in grid voltage of V105B. This results in an alteration of tube current and therefore a different DC plate level. The change in plate voltage of V105B appears as a proportional change in grid voltage of V108. This changes the cathode bias and current of RF amplifiers V109 and V110 in a direction to correct the RF amplifier output level to near its original value. In this manner, the output is maintained at the desired level at all frequencies.

4-13. Both halves of V104 function as voltage clamping cathode followers. V104B clamps the plate of V105A at the desired DC level as determined by a fixed grid potential of V104B. V104A functions in a similar manner to maintain the screen voltage of V105B at a fixed potential. Carrier Zero Set R128, in the grid circuit of V104, provides a voltage which will result in cutoff of V105B with zero potential on both control grids of V105. This in turn, causes RF amplifier cutoff, and establishes the zero reference for ATTENUATOR VERNIER control R129. Carrier Level Maximum Set R134, connected in a voltage dividing network with R129, establishes the maximum level of RF output when R129 is at its maximum position.

4-14. MODULATION. When modulation is used, the modulating voltage (internal or external) is fed through MODULATION SELECTOR switch S102, MODULATION AMPLITUDE control R117, and ATTENUATOR VERNIER control R129 to the grid of differential amplifier V105A. S102 selects the internal 400 c/s, 1000 c/s, or ground voltage from the modulation audio oscillator and amplifier V103, or the external AC or DC voltage from MODULATION INPUT/OUTPUT jack J102. When S102 is in the CW position, B+ is disconnected from V103, thus supplying a ground potential output. R117 controls the amplitude of modulation, and R129 allows settings of attenuation between any ATTENUATOR pushbutton values selected.

4-15. Modulation at the grid of V105A causes modulation to appear at the common cathodes of V105 and, therefore, the plate of V105B and grid of V108. V108 now functions as a modulator, varying the RF amplifiers cathode bias, and causing the RF output signal amplitude to vary in response to the modulating signal. The DC level at the grid of V105B varies in a similar manner since it is derived from the detected RF amplifier output.

4-16. The internally generated 400 c/s or 1000 c/s sinusoidal audio modulating voltage is provided by the modulator audio oscillator V103B. The circuit configuration is a modified Wien bridge oscillator in which the frequency determining elements form two legs of a bridge. The 400 c/s or 1000 c/s elements are selected by S102. Lamp RT101, in the third leg of the bridge, is a current limiting device used to maintain constant modulation signal amplitude. Modulation Level Set R114, in the fourth leg of the bridge, adjusts the modulation signal amplitude by regulating the feed-back to unbypassed V103A cathode resistance element RT101. Operating stability is further aided by the degenerative action of the unbypassed resistor in the cathode of V103B. When S102 is in either of the INT positions, the oscillator output from transformer T101 is available at MODULATION INPUT/OUTPUT jack J102.

4-17. The modulating signal from S102 is applied to the grid of meter cathode follower V102A. The signal at the cathode of V102A is coupled to meter rectifier CR101 and Percent Modulation Meter Set R123. The rectified voltage indicates percent modulation from zero to 100 percent on PERCENT MODULATION meter M101. R123 adjusts M101 for full scale deflection. An additional diode, CR102, prevents negative voltage being applied to the cathode of V102A.

4-18. CRYSTAL CALIBRATOR. Crystal calibration oscillator V101B is a crystal controlled circuit in which the screen functions as a plate element. Calibration interval frequencies 100k c/s or 1 Mc/s are selected by toggle switch S101. The oscillator output, and a sample of RF output from attenuator Z301, are coupled to the grid of crystal calibration mixer V101A. Crystal Frequency Set C103 adjusts the oscillators output frequencies.

4-19. The fundamental and harmonics of the 100 kc/s or 1 Mc/s, and the sampled RF output signal, are mixed in V101A. The difference frequency, appearing at the plate of V101A, is amplified by V102B and made available at PHONES jack J101.

4-20. POWER INPUT (See Figure 4-3). Power for the unit is provided through plug P201, the input line filter, fuse F201, and power switch S201 to the primary winding of power transformer T201. The transformer primary connections shown on the schematic diagram are for 115 VAC input. 230 VAC operation is accomplished by connecting the primary windings in series (refer to paragraph 2-11).

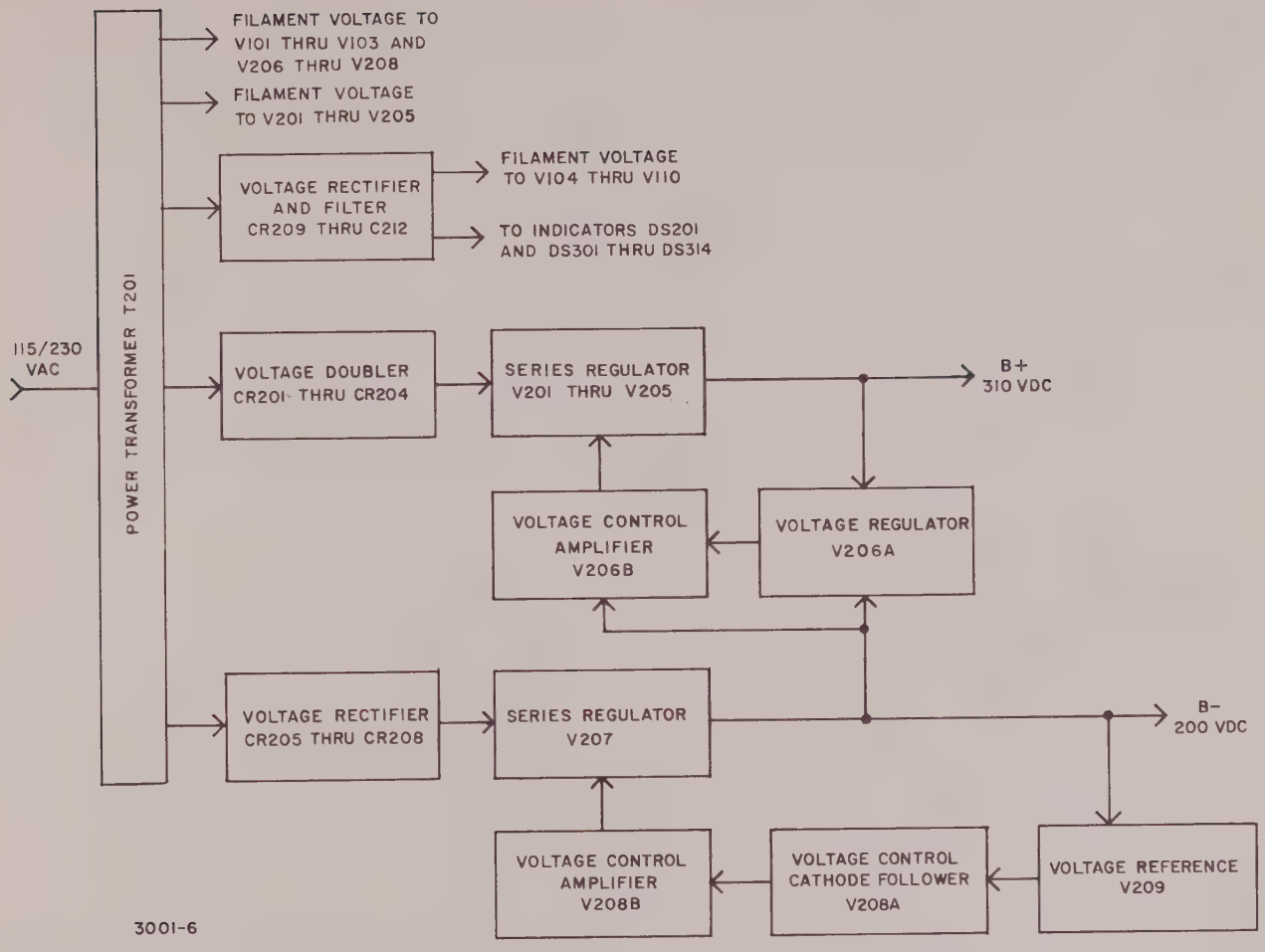

FILAMENT VOLTAGE TO V101 THRU V103 AND V206 THRU V208
FILAMENT VOLTAGE TO V201 THRU V205
VOLTAGE RECTIFIER AND FILTER CR209 THRU C212
FILAMENT VOLTAGE TO V104 THRU V110
TO INDICATORS DS201 AND DS301 THRU DS314
115/230 VAC
POWER TRANSFORMER T201
VOLTAGE DOUBLER CR201 THRU CR204
SERIES REGULATOR V201 THRU V205
B+ 310 VDC
VOLTAGE CONTROL AMPLIFIER V206B
VOLTAGE REGULATOR V206A
VOLTAGE RECTIFIER CR205 THRU CR208
SERIES REGULATOR V207
B- 200 VDC
VOLTAGE CONTROL AMPLIFIER V208B
VOLTAGE CONTROL CATHODE FOLLOWER V208A
VOLTAGE REFERENCE V209
3001-6

Figure 4-3. Detailed Block Diagram, Power Supply

4-21. -200 VDC POWER SUPPLY. The -200 VDC regulated power supply includes power transformer T201, voltage rectifier CR205 through CR208, series regulator V207, cathode follower V208A, control amplifier V208B, and voltage reference V209. The -200 VDC operating level is established by -200 VDC Set R227 in the grid circuit of V208B. The grid of V208 is maintained at a reference level determined by V209. A change in output voltage causes a proportional change at the grid of V208A, changing the conduction of V208B. The change appears on the grid of V207, correcting the current through V207 and returning the supply output to -200 VDC.

4-22. +310 VDC POWER SUPPLY. The +310 VDC regulated power supply includes a voltage doubler circuit CR201 through CR204 functioning as a rectifier, series regulators V201 through V205, control amplifier V206B, and voltage reference V206A. The circuit operation is similar to the -200 VDC power supply except that the established -200 VDC is used as a reference voltage for V206A and V206B.

4-23. FILAMENT SUPPLIES. V104 through V110 are supplied with a DC voltage which has been filtered and rectified from T201 secondary windings 9 and 10. This method of filament supply to the RF oscillator and amplifier circuits provides stability and insures low hum modulation. The filament source for the +310VDC power supply is returned to +310VDC. V101 through V103, and V206 through V208 are connected to -25 VDC, reducing their filament to cathode potentials to a minimum.

4-24. MISCELLANEOUS CIRCUIT CONSIDERATIONS. Extensive filtering is used on all positive and negative high voltage lines entering the RF section. Fuse F101 protects the +310 VDC line. The matrix forming the ATTENUATOR selection circuit for lamp DS301 through

DS314 is supplied with +6.0 VDC from bridge rectifier CR209 through CR212. Emitter follower Q101 provides a fixed reference level for the grid of differential amplifier V105A through ATTENUATOR VERNIER control R129. RANGE selector switch S104 inserts the proper RC filter into the plate circuit of V105B, inserts the proper capacitance into the ALC detector circuit CR105 and CR106, and actuates S103 during the band switching sequence. S103 causes a biasing of V105A which results in cutoff of RF amplifiers V109 and V110. Should V109 and V110 be allowed to operate with no load provided by the transformer coils in their plate circuits, their screen grids would draw excessive current, possibly damaging the tubes.

SECTION 5

MAINTENANCE

5-1. GENERAL.

5-2. Section 5 describes maintenance procedures for the Signal Generator. The section includes: disassembly, checks and adjustments, alignment, and troubleshooting procedures. Also, included in the section, are tables of test equipment required, tube replacement, adjustment function, front panel control settings, and continuity measurements. Figure 5-1 locates all internal adjustments, tubes, and transistors.

WARNING

Dangerous voltages are encountered while performing maintenance procedures. Never make internal electrical connections with power on. Use extreme care and caution while performing procedures, and in choosing range scales. Do not operate equipment for a long period with the +10 Δ DB ATTENUATOR pushbuton depressed.

5-3. DISASSEMBLY.

5-4. Disassembly of the unit is not recommended except when gaining access to a defective component or adjustment. Utilize all possible caution in reassembling.

5-5. CASE REMOVAL. To gain access to any internal component, remove the case as follows:

a. Disconnect unit from ac power source.

b. Slip bezel off.

c. Remove two screws on each side of top cover.

d. Remove top cover from unit.

e. Remove two screws on each side and bottom of bottom cover.

f. Remove chassis from bottom cover.

5-6. RF SECTION REMOVAL. If a malfunction is traced to the RF section, or access to the Carrier Zero Set or Oscillation Level Adjustments is required, remove the RF section as follows:

a. Disconnect unit from ac power source.

b. Remove all screws holding RF shield and RF shield bottom to the RF casting.

c. Remove the RF shield and RF shield bottom.

5-7. TEST EQUIPMENT REQUIRED.

5-8. Table 5-1 lists the test equipment required to adjust and align the Signal Generator. When the equipment listed is not available, an equivalent type should be used.

TABLE 5-1. TEST EQUIPMENT

Equipment	Model	Company	Use
Broadband Voltmeter Ohmmeter	9201	The Singer Company, Metrics Division	DC Voltmeter, VTVM, Ohmmeter.
Clip-On Milliammeter	428A/B	Hewlett Packard	Milliammeter.
Frequency Counter	524C/D	Hewlett Packard	Frequency Counter (10 cps to 10.1 MC).
Frequency Counter Plug-In Unit	525A	Hewlett Packard	Converter (10.1 MC to 100 MC).
Frequency Counter Plug-In Unit	526A	Hewlett Packard	Video Amplifier (10 cps to 10.1 MC, High Sensitivity).

TABLE 5-1. TEST EQUIPMENT (CONT).

Equipment	Model	Company	Use
Oscilloscope	545	Tektronix	Oscilloscope.
Oscilloscope Plug-In Unit	K	Tektronix	Amplifier (Fast Rise Time, DC to 30 MC).
Output Termination	AT102	The Singer Company, Metrics Division	Output Termination (50 ohms-0 DB).
Tuning Tool	Plastic	Any	Slug and Trimmer Capacitor Tuning.
Allen Wrench	Plastic No. 18	Any	Slug and Trimmer Capacitor Tuning (Band 6).

5-9. INTERNAL ADJUSTMENTS.

5-10. Table 5-2 provides a functional description of each internal adjustment. Figure 5-1 locates each adjustment.

TABLE 5-2. ADJUSTMENT FUNCTION

Adjustment	Function
C103	Adjusts 100 kc/s and 1 Mc/s frequencies of crystal calibration oscillator, V101B.
C401 through C406	Adjusts high band frequency of RF oscillator, V107, for each band.
C407 through C412	Adjusts high band current of RF amplifier, V109 and V110, for each band.
R114	Adjusts output level of internal modulation audio oscillator, V103.
R123	Adjusts indication of PERCENT MODULATION meter, M101.
R125	Adjusts zero modulation level of RF output.
R128	Adjusts zero level of RF output.
R134	Adjusts maximum level of RF output.

TABLE 5-2. ADJUSTMENT FUNCTION (Cont).

Adjustment	Function
R140	Adjusts oscillation level of RF oscillator, V107.
R157	Adjusts indication of RF output meter, M102.
R227	Adjusts output level of -200 VDC power supply.
T401 through T406	Adjusts low band frequency of RF oscillator, V107, for each band.
T407 through T412	Adjusts low band current of RF amplifier, V109 and V110, for each band.

5-11. TUBE AND TRANSISTOR REPLACEMENT.

5-12. The equipment is thoroughly factory tested and aligned prior to shipment, and with normal usage should function as described in previous sections. However, the unit may malfunction due to a weak or defective tube. Rather than make lengthy adjustments which may complicate isolation of the trouble, first try tube substitution. If the malfunction is isolated to a defective tube, only minor adjustment may be required. Table 5-3 lists the adjustments that may require a touch-up alignment when tubes age or are replaced. Figure 5-1 locates all tubes.

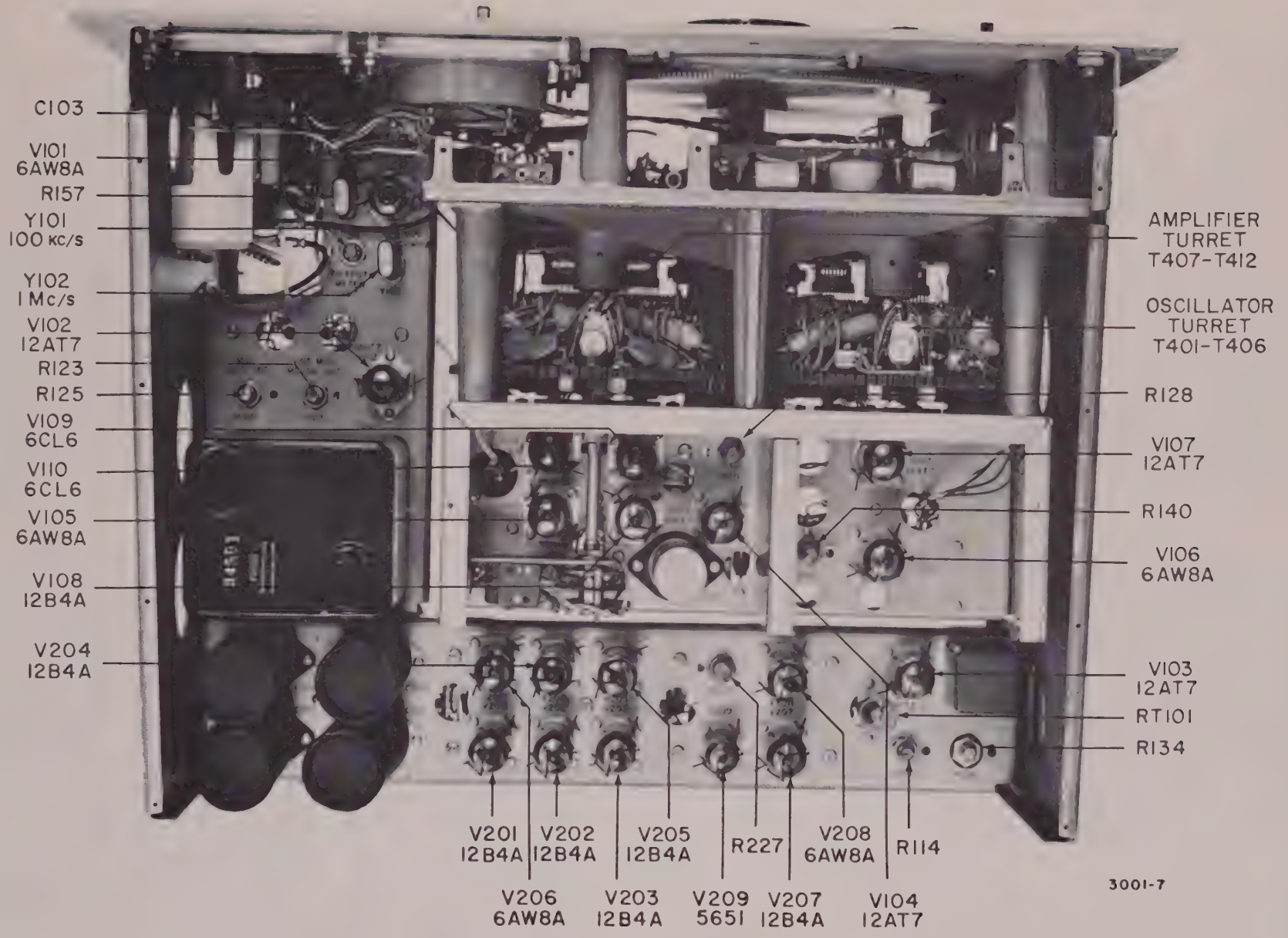


Figure 5-1. Tube and Adjustment Locations

TABLE 5-3. TUBE AND TRANSISTOR REPLACEMENT

Tube	Adjustment	Paragraph
V101	Crystal Calibrator	5-19
V102	Crystal Calibrator, Percent Modulation Meter	5-19, 5-23
V103	Internal Audio Oscillator, Carrier Zero Set	5-20, 5-22
V104, V105, V109, V110	Carrier Zero Set, RF Output Meter	5-22, 5-25
V106, V107	Oscillation Level, RF Output Meter	5-21, 5-25
V108	Percent Modulation RF Output Meter	5-23, 5-25
V201 through V209	Power Supply	5-18
Q101	Carrier Zero Set	5-22

5-13. CHECKS AND ADJUSTMENTS.

5-14. All checks, adjustments and alignments are to be performed only when determined necessary. Adjustments performed when not needed or when a malfunction exists, may further complicate trouble isolation. Table 2-1 checks the operability of all front panel controls. Table 2-1 and 5-5 should be utilized before attempting any adjustments.

5-15. The following checks and adjustments are listed in the order in which they are to be performed during complete adjustment procedures. When performing any one procedure, accomplish all steps, including the references to other adjustments. Also, perform the Meter Mechanical Zero Adjustment, paragraph 5-17, before performing maintenance procedures involving the use of either front panel meter.

5-16. INITIAL CONTROL SETTINGS. Before performing any check, adjustment, or alignment, position all front panel controls to the settings listed in Table 5-4, and allow a 30 minute warmup.

TABLE 5-4. INITIAL CONTROL SETTINGS

Control	Setting
POWER toggle switch	ON
RANGE selector switch	Band 3
CALIBRATE control	Hairline cursor in vertical position
FREQUENCY controls	1 Mc/s
MODULATION SELECTOR switch	CW
MODULATION AMPLITUDE control	Fully counterclockwise
CRYSTAL CALIBRATOR toggle switch	OFF
ATTENUATOR pushbuttons	Released
ATTENUATOR VERNIER control	Fully counterclockwise

NOTE

Connect Output Termination AT-102 to RF OUTPUT 50 Ω jack, J301, while performing all maintenance procedures. Rotate AT-102 to the second (ODB) output position.

5-17. METER MECHANICAL ZERO ADJUSTMENT. Mechanical zero of the meter movement is attained when the unit is at normal operating temperature, in its normal operating position, and turned off. Ensure meter mechanical zero before performing any procedure involving the use of either front panel meter. Proceed as follows:

a. Set POWER toggle switch to off position and allow 30 seconds for discharge of all capacitors.

b. Rotate meter zero adjust screw on front of meter in a clockwise direction until meter pointer reaches maximum up scale travel.

c. Continue rotating adjust screw clockwise until pointer returns to and is aligned with meter zero mark.

d. If pointer is adjusted past zero mark, repeat steps b and c.

5-18. POWER SUPPLY CHECK AND ADJUSTMENT. The -200 VDC regulated power supply supplies the reference voltage to the +310 VDC regulated power supply. Adjustment of 200 V SET, R227, should correct +310 VDC output. Proceed as follows:

a. Connect DC voltmeter between pin 2 of V209 (-) and chassis (+), and observe voltmeter indication of -200 ± 1.0 VDC.

b. If necessary, adjust 200 V SET, R227, for a voltmeter indication of -200 VDC.

c. Connect DC voltmeter between pin 3 of V206 (+) and chassis (-), and observe voltmeter indication of +310 + 10 VDC.

d. Connect DC voltmeter between pin 5 of V106 (-) and chassis (+), and observe voltmeter indication of -25 ± 3 VDC.

5-19. CRYSTAL CALIBRATION CHECK AND ADJUSTMENT. To adjust output frequencies of Crystal Calibrator, proceed as follows:

a. Set CRYSTAL CALIBRATOR toggle switch to 100 kc/s.

b. Connect frequency counter to pin 2 of V101, and observe counter indication of 100.000 ± 0.01 kc/s.

c. Set CRYSTAL CALIBRATOR toggle switch to 1 Mc/s.

d. Observe counter indication of 1000.00 ± 0.1 kc/s.

e. If frequency of step b or d exceeds tolerances, adjust Crystal Frequency Set, C103, until both measurements are within limits with center frequencies as near as possible to 100 kc/s and 1 Mc/s.

f. Set CRYSTAL CALIBRATOR toggle switch to OFF.

5-20. INTERNAL AUDIO OSCILLATOR CHECK AND ADJUSTMENT. To adjust output level of internal oscillator, proceed as follows:

a. Position MODULATION SELECTOR switch to INT 1000 c/s, and rotate MODULATION AMPLITUDE control for a PERCENT MODULATION meter indication of 50 percent.

b. Connect VTVM between junction of R171 and contact 12 of S102 front, and chassis, and observe VTVM indication of 4.3 volts rms.

c. If necessary, adjust Modulation Level Set, R114, for a VTVM indication of 4.3 volts rms.

d. Position MODULATION SELECTOR switch to INT 400 c/s. Indication on VTVM should remain at 4.3 volts rms.

5-21. OSCILLATION LEVEL ADJUSTMENT. Proceed as follows:

a. Attach clip-on milliammeter probe to red wire connected between R145 (100 ohm, 1 watt) and pin 3 of RF oscillator turret contacts.

b. Position RANGE selector switch to band 6, and depress -20 Δ DB ATTENUATOR pushbutton.

c. Rotate FREQUENCY controls throughout entire range of band 6, while observing milliammeter for 25 ma or less at low end of band, a decrease of current at mid-band, and a rise in current to less than 32 ma at high end of band.

d. If necessary, adjust Oscillation Level Adjustment, R140, for the milliammeter indications stated in step c.

e. If R140 was adjusted, perform Carrier Zero Set Adjustment, paragraph 5-22.

5-22. CARRIER ZERO SET CHECK AND ADJUSTMENT. Proceed as follows:

a. Depress -20 Δ DB ATTENUATOR pushbutton.

b. Connect DC voltmeter between pin 8 of V105B (+) and chassis (-), and observe voltmeter indication of +165 VDC.

c. If necessary, adjust Carrier Zero Set, R128, for a voltmeter indication of +165 VDC.

d. Set POWER toggle switch to off position.

e. Install a 0.1 mfd capacitor between pin 7 of V105B and ground to prevent possible RF amplifier oscillation.

f. Attach clip-on milliammeter probe to red wire connected between R154 (100 ohm, 2 watt) and pin 3 of RF amplifier turret contacts.

g. Connect VTVM to output of output termination AT-102.

h. Adjust RF output to 38.0 Mc/s on band 6, release -20Δ DB ATTENUATOR pushbutton, and set POWER toggle switch to ON. Allow 20 minute warm-up.

i. Rotate ATTENUATOR VERNIER control for a VTVM indication of 1.0 volts rms.

j. Observe RF output meter voltage. If RF output meter and VTVM indications differ by more than 0.1 volts rms, perform RF Output Meter Adjustment, paragraph 5-25.

k. Rotate ATTENUATOR VERNIER control fully clockwise, and observe VTVM indication of 1.05 volts rms.

l. If necessary, adjust Carrier Level Maximum Set, R134, for a VTVM indication of 1.05 volts rms.

m. Rotate ATTENUATOR VERNIER control fully counterclockwise, and observe milliammeter indication of 0.15 ma.

n. If necessary, adjust Carrier Zero Set, R128, for a milliammeter indication of 0.15 ma.

o. Set POWER toggle switch to off position.

p. Disconnect 0.1 mfd capacitor and clip-on milliammeter.

q. If R134 or R128 were adjusted, perform Percent Modulation Meter Adjustment, paragraph 5-23.

5-23. PERCENT MODULATION METER CHECK AND ADJUSTMENT. Proceed as follows:

a. Connect oscilloscope to output of output termination, AT-102.

b. Rotate ATTENUATOR VERNIER control for an RF output meter indication of 1.0 volts rms.

c. Adjust oscilloscope for a display of several cycles 4 centimeters high.

d. Position MODULATION SELECTOR switch to INT 1000 c/s.

e. Rotate MODULATION AMPLITUDE control until oscilloscope display is 6 centimeters high at the peaks and 2 centimeters high at the troughs.

f. Adjust Modulation Meter Set, R123, for a PERCENT MODULATION meter indication of 50 percent.

g. Rotate ATTENUATOR VERNIER control for an RF output meter indication of 0.2 volt rms.

h. Position MODULATION SELECTOR switch to CW.

i. Adjust oscilloscope for a display of several cycles 4 centimeters high.

j. Position MODULATION SELECTOR switch to INT 1000 c/s, and observe oscilloscope display.

k. If necessary, adjust Carrier Zero Set, R128, for an oscilloscope display that is 6 centimeters high at the peaks and 2 centimeters high at the troughs. While adjusting R128, maintain an RF output meter indication of 0.2 volts rms with the ATTENUATOR VERNIER control.

l. If R128 was adjusted in step k, position MODULATION SELECTOR switch to CW, rotate ATTENUATOR VERNIER control for an RF output meter indication of 1.0 volts rms, and repeat steps c through k.

m. If R128 was adjusted in step k, perform Maximum Carrier Set and Modulation Zero Set Adjustment, paragraph 5-24.

5-24. MAXIMUM CARRIER SET AND MODULATION ZERO SET CHECK AND ADJUSTMENT. Proceed as follows:

a. Position MODULATION SELECTOR switch to EXT AC, and rotate ATTENUATOR VERNIER control fully clockwise.

b. Connect VTVM to output of output termination, AT-102.

c. Rotate FREQUENCY controls throughout entire range of each band, while observing VTVM. Note the band and frequency at the lowest VTVM reading.

d. Position RANGE selector switch and FREQUENCY controls to the band and frequency of the lowest reading of step c.

e. Position MODULATION SELECTOR switch to CW and check for VTVM indication of 1.05 volts rms.

f. If necessary, adjust Maximum Carrier Set, R134, for a VTVM indication of 1.05 volts rms.

g. Position MODULATION SELECTOR switch to EXT AC, and observe VTVM for no change.

h. If necessary, adjust Modulation Zero Set, R125, such that when the MODULATION SELECTOR switch is switched between CW and EXT AC positions (with MODULATION AMPLITUDE control at any setting), the VTVM indication remains constant.

i. Repeat steps e through h until no further adjustment of R134 and R125 is required.

5-25. RF OUTPUT METER CHECK AND ADJUSTMENT. Proceed as follows:

a. Connect VTVM to output of output termination, AT-102.

b. Position RANGE selector switch and FREQUENCY controls to midband of band 6, 38 Mc/s.

c. Rotate ATTENUATOR VERNIER control for VTVM indication of 0.9 volts rms, and observe RF output meter indication of 0.9 volts rms.

d. If necessary, adjust Output Meter Set, R157, for an RF output meter indication of 0.9 volts rms.

e. Rotate FREQUENCY controls throughout entire range of each band, maintaining an RF output meter indication of 0.9 volts rms with the ATTENUATOR VERNIER control. Note the highest and lowest VTVM readings, and the band and frequency at the highest VTVM reading.

f. Position RANGE selector switch and FREQUENCY controls to the band and frequency of the highest VTVM reading of step e.

g. Determine the difference between the highest and lowest readings of step e. Add one half of the difference to 0.9 volts rms.

h. Rotate ATTENUATOR VERNIER control for a VTVM indication of the sum obtained in step g, and observe an RF output meter indication of 0.9 volts rms.

i. If necessary, adjust R157 for an RF output meter indication of 0.9 volts rms.

5-26. ALIGNMENT.

5-27. Alignment procedures are to be performed only after the checks and adjustments of paragraphs 5-13 through 5-25 have been performed, but have failed to yield the desired results. Before attempting alignment, be sure existing malfunctions are not a result of defective tubes or other components.

5-28. Before performing any alignment procedures, position all front panel controls to the settings listed in Table 5-4, and allow a 30 minute warm-up. For primary coil slug and trimmer capacitor tuning, use a plastic screwdriver or tuning tool. For band 6 primary coil tuning slug, use a No. 18 plastic allen wrench.

5-29. RF OSCILLATOR ALIGHMENT. Proceed as follows:

a. Connect a 3 turn, 1 inch diameter pickup coil of insulated wire to a UG-1094/U connector for the frequency counter input. Tape all exposed metal.

b. Depress -20Δ DB ATTENUATOR pushbutton, and position RANGE selector switch to band 6.

c. Place pickup coil in field of oscillator coil in use.

d. Rotate FREQUENCY controls to low end of band, and observe frequency counter indication of low band frequency ± 1 percent.

e. If necessary, adjust band oscillator primary coil tuning slug for correct frequency.

f. Rotate FREQUENCY controls to high end of band 6, and observe frequency counter high band frequency ± 1 percent.

g. If necessary, adjust band oscillator trimmer capacitor for correct frequency.

h. Repeat steps d through g until frequency is correct for both ends of the band.

i. Repeat steps c through h for bands 1 through 5.

j. If any adjustment was needed for band 6, perform Oscillation Level Adjustment, paragraph 5-21.

5-30. RF AMPLIFIER ALIGNMENT. Proceed as follows:

a. Set POWER toggle switch to off position.

b. Install a 0.1 mfd capacitor between pin 7 of V105B and ground, to prevent possible RF amplifier oscillation.

c. Attach clip-on milliammeter probe to red wire connected between R154 (100 ohm, 2 watt) and pin 3 of RF amplifier turret contacts.

d. Position RANGE selector switch to band 6, and depress -20Δ DB ATTENUATOR pushbutton.

e. Set POWER toggle switch to ON.

f. Rotate FREQUENCY controls to low end of band.

g. Adjust band amplifier primary coil tuning slug for minimum milliameter current at low end of band.

h. Rotate FREQUENCY controls to high end of band.

i. Adjust band amplifier trimmer capacitor for minimum milliammeter current at high end of band.

j. Repeat steps f through i for bands 1 through 5.

k. Set POWER toggle switch to off position.

l. Disconnect 0.1 mfd capacitor and clip-on milliammeter.

5-31. TUNING CAPACITOR CONTINUITY CHECK.

5-32. Perform the following after any unit repair:

a. Disconnect unit from ac power source.

b. Connect ohmmeter between chassis and stator section of C125, C126, C131, and C132, in turn.

CAUTION

Do not short-out these capacitors. Shorting of these capacitors may result in damage to other component parts.

c. Rotate FREQUENCY controls throughout entire range, and check VOM for normal indication of infinite resistance.

5-33. TROUBLESHOOTING.

5-34. Table 5-5 is provided as an aid in troubleshooting the Model SG-8. A variety of symptoms of possible malfunctions is listed, and for each symptom the probable cause and recommended procedure for servicing is provided. As an additional aid in tracing the probable malfunction, or in checking continuity, refer to the overall schematic at the end of the manual.

TABLE 5-5. TROUBLESHOOTING CHART

Symptom	Probable Cause	Procedure
Unit inoperative.	Incorrect input power source.	Check input power source for correct voltage. Change wiring, if applicable, in accordance with Section 2.
	Fuse F201 burned out.	Replace defective fuse.
	Switch S201 defective.	Replace defective switch.
	Transformer T201 defective.	Check continuity of transformer windings. Replace transformer if defective.
	Defective circuit.	Check circuit continuity. Repair or replace defective component.
No -200 VDC output	Transformer T201 195 VAC secondary defective.	Check between transformer pins 7 and 8 for 195 VAC. Replace transformer, if defective.
	Diode CR205, CR206, CR207, or CR208 defective.	Replace defective diode.
	Capacitor C210 defective.	Replace defective capacitor.
	Vacuum tube V207, V208, or V209 defective.	Replace defective tube.
	Defective circuit.	Check circuit continuity. Repair or replace defective component.
No +310 VDC output	Transformer T201 315 VAC secondary defective.	Check between transformer pins 5 and 6 for 315 VAC. Replace transformer, if defective.

TABLE 5-5. TROUBLESHOOTING CHART (CONT).

Symptom	Probable Cause	Procedure
No +310 VDC output (cont).	Resistor R201 defective. Diode CR201, CR202, CR203, or CR204 defective. Capacitor 206, or 207 defective. Vacuum tube V201, V202, V203, V204, V205, or V206 defective. Defective circuit.	Replace defective resistor. Replace defective diode. Replace defective capacitor. Replace defective tube. Check circuit continuity. Repair or replace defective component.
No -25 VDC output.	Transformer T201 27 VAC secondary defective. Resistor R236 defective. Diode CR209, CR210, CR211, or CR212 defective. Capacitor C211, C212, or C213 defective. Choke coil L203 defective. Defective circuit.	Check between transformer pins 9 and 10 for 27 VAC. Replace transformer, if defective. Replace defective resistor. Replace defective diode. Replace defective capacitor. Replace choke coil. Check circuit continuity. Repair or replace defective component.
No filament voltage to vacuum tubes V201, V202, V203, V204, and V205.	Transformer T201 6.3 VAC. 1.5 ampere secondary defective. Defective circuit.	Check between transformer pins 11 and 12 for 6.3 VAC. Replace transformer, if defective. Check circuit continuity. Repair or replace defective component.
No filament voltage to vacuum tubes V101, V102, V103, V206, V207, and V208.	Transformer T201 6.3 VAC 3.2 ampere secondary defective. Defective circuit.	Check between transformer pins 13 and 14 for 6.3 VAC. Replace transformer, if defective. Check circuit continuity. Repair or replace defective component.
ATTENUATOR RANGE indicators not lighted.	Resistor R229 defective. Switch S301, S302, S303, S304, or S305 defective. Diode CR301, CR302, CR303, CR304, CR305, CR306, CR307, CR308, CR309, or CR310 defective. Indicator lamp burned out. Defective circuit.	Replace defective resistor. Replace defective switch. Replace defective diode. Replace defective lamp. Check circuit continuity. Repair or replace defective component.
No 100 kc/s or 1 Mc/s crystal output.	Crystal Y101, or Y102 defective. Switch S101 defective. Vacuum tube V101, or V102 defective. Defective circuit.	Check crystal frequency output. Refer to paragraph 5-19. Replace defective crystal. Replace defective switch. Replace defective tube. Check circuit continuity. Repair or replace defective component.
No 400 c/s or 1000 c/s modulation.	Switch S102 defective. Vacuum tube V103 defective.	Replace defective switch. Replace defective tube.

TABLE 5-5 TROUBLESHOOTING CHART (CONT).

Symptom	Probable Cause	Procedure
No 400 c/s or 1000 c/s modulation. (Cont).	Transformer T101 defective. Defective circuit.	Check transformer continuity. Replace transformer, if defective. Check circuit continuity. Repair or replace defective component.
No indication on Percent Modulation Meter, M101.	Vacuum tube V102 defective. Capacitor C106 defective Diode CR101 defective. Resistor R123 defective Meter M101 defective. Defective circuit.	Replace defective tube. Replace defective capacitor. Replace defective diode. Replace defective resistor. Replace defective meter. Check circuit continuity. Repair or replace defective component.
No RF output or incorrect RF output.	Vacuum tube V104, or V105 defective. Vacuum tube V106 defective. Vacuum tube V107 defective. Vacuum tube V108 defective. Vacuum tube V109, or V110 defective. Diode CR104 defective. Capacitor C135, or C136 defective. Choke coil L102, or L103 defective. Capacitor C130, or C134 defective. Fuse F101 burned out. Capacitor C125, or C126 defective. Capacitor C131, or C132 defective. Switch S104 defective. Transistor Q101 defective. Defective circuit.	Replace defective tube. Replace defective tube. Replace defective tube. Replace defective tube. Replace defective tube. Replace defective diode. Replace defective capacitor. Replace defective choke coil. Replace defective capacitor. Replace defective fuse. Replace defective capacitor. Replace defective capacitor. Replace defective switch. Replace defective transistor. Check circuit continuity. Repair or replace defective component.
No indication on RF output meter, M102.	Resistor R156 defective. Capacitor C138, or C140 defective. Choke coil L104 defective. Meter M102 defective. Defective circuit.	Replace defective resistor. Replace defective capacitor. Replace defective choke coil. Replace defective meter. Check circuit continuity. Repair or replace defective component.
Incorrect or no attenuation.	Switch S301, S302, S303, or S304 defective. Defective circuit.	Replace defective switch. Check circuit continuity. Repair or replace defective component.
No 10 db power gain when red + 10 Δ DB ATTENUATOR push-button is depressed.	Switch S305 defective. Relay K101 defective. Defective circuit.	Replace defective switch. Replace defective relay. Check circuit continuity. Repair or replace defective component.

SECTION 6

REPLACEMENT PARTS LIST

6-1. GENERAL.

6-2. This section contains a list of all electrical and electronic replaceable parts.

6-3. The parts list is arranged in alphabetical and numerical order by the circuit reference designation, and is cross-referenced to its description and part number.

6-4. Values and ratings of some components are nominal, and variations may exist in some models. In cases where variations are found, use the exact replacement for the component found in the equipment.

6-5. When ordering parts from the factory, always include the following information:

a. Instrument Model Number
b. Instrument Serial Number
c. Singer Part Number
d. Reference Designation
e. Part Description
f. Quantity Required

Ref. Desig.	Description	Singer Part No.
C101	CAPACITOR: fixed, mica, 69 mmf ± 5%, 500 volt	000-221-60-024
C102	CAPACITOR: fixed, ceramic, 0.005 mf ± 20%, 500 volt	000-218-99-007
C103	CAPACITOR: variable, ceramic 5-20 mf, 500 volt	000-223-02-006
C104	CAPACITOR: fixed, ceramic, 0.05 mf ± 20%, 500 volt	000-218-99-023
C105	CAPACITOR: fixed, ceramic, 0.01 mf ± 20%, 500 volt	000-218-99-003
C106	CAPACITOR: fixed, electrolytic 20 mf, 25 volt	000-219-01-032
C107	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C108	CAPACITOR: fixed, ceramic 0.02 mf + 100%, -0%, 500 volt	000-218-99-006
C109	CAPACITOR: fixed, ceramic 0.005 mf ± 20%, 500 volt	000-218-99-007
C110	CAPACITOR: fixed, molded mica, 5600 mf ± 1%, 500 volt	000-221-44-121
C111	CAPACITOR: fixed, molded mica, 5600 mf ± 1%, 500 volt	000-221-44-121
C112	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C113	CAPACITOR: fixed, mylar, 1 mf ± 10%, 200 volt	000-222-68-027
C114	CAPACITOR: fixed, ceramic, 0.01 mf ± 20%, 500 volt	000-218-99-003
C115	CAPACITOR: fixed, ceramic, 0.01 mf ± 20%, 500 volt	000-218-99-003
C116	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C117	CAPACITOR: fixed, mica, 1000 mmf ± 10%, 500 volt	000-221-93-060
C118	CAPACITOR: fixed, paper, tubular, 0.0033 mf ± 10%, 600 volt	000-222-64-049
C119	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C120	CAPACITOR: fixed, ceramic, 0.01 mf ± 20%, 500 volt	000-218-99-003
C121	CAPACITOR: fixed, ceramic, 0.01 mf ± 20%, 500 volt	000-218-99-003
C122	CAPACITOR: fixed, ceramic, 0.01 mf ± 20%, 500 volt	000-218-99-003
C124	CAPACITOR: fixed, ceramic, 0.01 mf ± 20%, 500 volt	000-218-99-003
C125	CAPACITOR: variable, air, 10.75-442.2 mmf, 2 gang	000-223-01-001

Ref. Desig.	Description	Singer Part No.
C126	CAPACITOR: variable, air, 10.75-442.2 mmf, 2 gang (part of C125)	000-223-01-001
C127	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C128	CAPACITOR: fixed, ceramic, 0.01 mf ± 20%, 500 volt	000-218-99-003
C129	CAPACITOR: fixed, mica, 22 mmf ± 5%, 500 volt	000-221-60-006
C130A	CAPACITOR: fixed, electrolytic, 10-10-10 mf, 450 volt	000-219-24-001
C130B	CAPACITOR: fixed, electrolytic, 10-10-10 mf, 450 volt (part of C130A)	000-219-24-001
C130C	CAPACITOR: fixed, electrolytic, 10-10-10 mf, 450 volt (part of C130A)	000-219-24-001
C131	CAPACITOR: variable, air, 10.75-442.2 mmf, 2 gang	000-223-01-004
C132	CAPACITOR: variable, air, 10.75-442.2 mmf, 2 gang (part of C131)	000-223-01-004
C134	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C135	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C136	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C137	CAPACITOR: fixed, ceramic, feed-through, 1000 mmf ± 20%, 500 volt	000-220-99-003
C138	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C139	CAPACITOR: fixed, ceramic, 15 mmf ± 2.5%, 500 volt	000-218-99-005
C140	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C141	CAPACITOR: fixed, ceramic, 0.01 mf ± 20%, 500 volt	000-218-99-003
C142	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C143	CAPACITOR: fixed, mica, 120 mmf ± 5%, 500 volt	000-221-60-039
C144	CAPACITOR: fixed, mica, 0.0018 mf ± 5%, 500 volt	000-221-44-078
C145	CAPACITOR: fixed, mica, 0.0047 mf ± 5%, 500 volt	000-221-44-114
C146	CAPACITOR: ceramic, disc, 0.03 mf ± 20%, 500 volt	556060-034
C147	CAPACITOR: fixed, mica, 620 mmf ± 5%, 500 volt	000-221-60-096

Ref. Desig.	Description	Singer Part No.
C149	CAPACITOR: fixed, mica, 120 mmf ± 5%, 500 volt	000-221-60-039
C150	CAPACITOR: fixed, mica, 100 mmf ± 5%, 500 volt	556076-013
C151	CAPACITOR: fixed, mica, 7 mmf ± 5%, 300 volt	000-221-01-002
C152	CAPACITOR: fixed, mica, 0.0082 mf ± 5%, 500 volt	000-221-66-081
C201	CAPACITOR: fixed, mica, 1000 mmf ± 20%, 500 volt	000-221-93-061
C202	CAPACITOR: fixed, mica, 1000 mmf ± 20%, 500 volt	000-221-93-061
C203	CAPACITOR: fixed, paper tubular, 0.1 mf ± 10%, 600 volt	000-222-07-142
C204	CAPACITOR: fixed, paper tubular, 0.1 mf ± 10%, 600 volt	000-222-07-142
C205	CAPACITOR: fixed, ceramic, 0.01 mf ± 20%, 500 volt	000-218-99-003
C206	CAPACITOR: fixed, electrolytic, 120 x 40 mf, 400 volt	000-219-03-058
C207A	CAPACITOR: fixed, electrolytic, 120 x 40 mf, 400 volt	000-219-03-058
C207B	CAPACITOR: fixed, electrolytic, 120 x 40 mf, 400 volt (part of C207A)	000-219-03-058
C208	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C209	CAPACITOR: fixed, ceramic, 0.01 mf ± 20%, 500 volt	000-218-99-003
C210A	CAPACITOR: fixed, electrolytic, 120 x 40 mf, 400 volt	000-219-03-058
C210B	CAPACITOR: fixed, electrolytic, 120 x 40 mf, 400 volt (part of C210A)	000-219-03-058
C211	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C212	CAPACITOR: fixed, electrolytic, 500 mf, 50 volt	000-219-02-013
C213	CAPACITOR: fixed, mylar, 0.1 mf ± 20%, 600 volt	000-222-99-002
C301	CAPACITOR: fixed, ceramic, 2.2 mmf ± 0.5 mmf, 500 volt	000-218-99-002
C401	CAPACITOR: variable, ceramic, 1.8-8.9 mmf	000-223-99-002
C402	CAPACITOR: variable, ceramic, 1.8-8.9 mmf	000-223-99-002
C403	CAPACITOR: variable, ceramic, 1.7-11.0 mmf	000-223-99-003
C404	CAPACITOR: variable, ceramic, 1.7-11.0 mmf	000-223-99-003
C405	CAPACITOR: variable, ceramic, 1.7-11.0 mmf	000-223-99-003
C406	CAPACITOR: variable, ceramic, 1.7-11.0 mmf	000-223-99-003
C407	CAPACITOR: variable, ceramic, 5-20 mf, 500 volt	000-223-02-006
C408	CAPACITOR: variable, ceramic, 5-20 mf, 500 volt	000-223-02-006
C409	CAPACITOR: variable, ceramic, 5-20 mf, 500 volt	000-223-02-006
C410	CAPACITOR: variable, ceramic, 5-20 mf, 500 volt	000-223-02-006
C411	CAPACITOR: variable, ceramic, 5-20 mf, 500 volt	000-223-02-006
C412	CAPACITOR: variable, ceramic, 5-20 mf, 500 volt	000-223-02-006
C413	CAPACITOR: fixed, mica, 47 mmf ± 5%, 500 volt	556079-025
C414	CAPACITOR: fixed, mica, 24 mmf ± 5%, 500 volt	556076-034
C415	CAPACITOR: ceramic, disc, 0.05 mf ± 20%, 500 volt	556060-081
C416	CAPACITOR: ceramic, disc, 0.05 mf ± 20%, 500 volt	556060-081
C417	CAPACITOR: ceramic disc, 0.01 mf ± 20%, 500 volt	000-218-03-010
C418	CAPACITOR: ceramic, disc, 0.01 mf ± 20%, 500 volt	000-218-03-010
C419	CAPACITOR: ceramic, disc, 0.01 mf ± 20%, 500 volt	000-218-03-010
C420	CAPACITOR: ceramic, disc, 0.01 mf ± 20%, 500 volt	000-218-03-010
C421	CAPACITOR: ceramic, disc, 0.01 mf ± 20%, 500 volt	000-218-03-010
C422	CAPACITOR: ceramic, disc, 0.01 mf ± 20%, 500 volt	000-218-03-010
C423	CAPACITOR: ceramic, disc, 0.01 mf ± 20%, 500 volt	000-218-03-010
C424	CAPACITOR: ceramic, disc, 0.01 mf ± 20%, 500 volt	000-218-03-010
C425	CAPACITOR: fixed, mica, 5 mmf ± 20%, 500 volt	556085-003
C501	CAPACITOR: fixed, silvered, mica, 33 mmf ± 5%, 500 volt	000-221-99-017
C502	CAPACITOR: fixed, mica, 36 mmf ± 5%, 500 volt	000-221-99-018
C503	CAPACITOR: fixed, silvered, mica, 15 mmf ± 5%, 500 volt	000-221-99-016
C504	CAPACITOR: fixed, mica, 36 mmf ± 5%, 500 volt	000-221-99-018

Ref. Desig.	Description	Singer Part No.
C505	CAPACITOR: fixed, silvered, mica, 33 mmf ± 5%, 500 volt	000-221-99-017
CR101	DIODE: semiconductor, germanium	000-359-02-004
CR102	DIODE: semiconductor, germanium	000-359-02-004
CR104	DIODE: semiconductor	000-359-99-003
CR105	DIODE: semiconductor	000-359-99-003
CR106	DIODE: semiconductor	000-359-99-003
CR201	DIODE: semiconductor, silicone	000-359-01-005
CR202	DIODE: semiconductor, silicone	000-359-01-005
CR203	DIODE: semiconductor, silicone	000-359-01-005
CR204	DIODE: semiconductor, silicone	000-359-01-005
CR205	DIODE: semiconductor, silicone	000-359-01-005
CR206	DIODE: semiconductor, silicone	000-359-01-005
CR207	DIODE: semiconductor, silicone	000-359-01-005
CR208	DIODE: semiconductor, silicone	000-359-01-005
CR209	DIODE: semiconductor, silicone, 100 PIV, 500 ma	000-359-01-002
CR210	DIODE: semiconductor, silicone, 100 PIV, 500 ma	000-359-01-002
CR211	DIODE: semiconductor, silicone, 100 PIV, 500 ma	000-359-01-002
CR212	DIODE: semiconductor, silicone, 100 PIV, 500 ma	000-359-01-002
CR301	DIODE: semiconductor	000-359-01-007
CR302	DIODE: semiconductor	000-359-01-007
CR303	DIODE: semiconductor	000-359-01-007
CR304	DIODE: semiconductor	000-359-01-007
CR305	DIODE: semiconductor	000-359-01-007
CR306	DIODE: semiconductor	000-359-01-007
CR307	DIODE: semiconductor	000-359-01-007
CR308	DIODE: semiconductor	000-359-01-007
CR309	DIODE: semiconductor	000-359-01-007
CR310	DIODE: semiconductor	000-359-01-007
DS201	LAMP: indicating, 6 volt, incandescent, bayonet base	556002-006
DS301	LAMP: indicating, 6 volt	000-555-99-004
DS302	LAMP: indicating, 6 volt	000-555-99-004
DS303	LAMP: indicating, 6 volt	000-555-99-004
DS304	LAMP: indicating, 6 volt	000-555-99-004
DS305	LAMP: indicating, 6 volt	000-555-99-004
DS306	LAMP: indicating, 6 volt	000-555-99-004
DS307	LAMP: indicating, 6 volt	000-555-99-004
DS308	LAMP: indicating, 6 volt	000-555-99-004
DS309	LAMP: indicating, 6 volt	000-555-99-004
DS310	LAMP: indicating, 6 volt	000-555-99-004
DS311	LAMP: indicating, 6 volt	000-555-99-004
DS312	LAMP: indicating, 6 volt	000-555-99-004
DS313	LAMP: indicating, 6 volt	000-555-99-004
DS314	LAMP: indicating, 6 volt	000-555-99-004
E301	CONNECTOR: receptacle, electrical, cable termination	000-275-99-003
E302	CONNECTOR: receptacle, electrical, cable termination	000-275-99-003
E303	CONNECTOR: receptacle, electrical, cable termination	000-275-99-003
E501	CONNECTOR: receptacle, electrical, cable termination	000-275-99-003
E502	CONNECTOR: receptacle, electrical, cable termination	000-275-99-003
F101	FUSE: cartridge, 15-100 ampere, 250 volt	000-427-02-002
F201	FUSE: cartridge, 2 ampere, 125 volt	556006-021
J101	JACK, electrical	556010-225
J102	CONNECTOR: coaxial, receptacle, electrical	000-273-99-005
J301	CONNECTOR: receptacle, electrical bulkhead adapter	000-275-99-004
J501	CONNECTOR: electrical, bulkhead jack	000-275-99-002
K101	RELAY: electrical, 3.5 ma, 5 K, 60 mw	000-727-99-002
L101	COIL: electrical, fixed, 4.5 mh, AC DC	000-255-01-037
L102	COIL: electrical, fixed, 4.5 mh, AC DC	000-255-01-037
L103	COIL: electrical, fixed, 4.5 mh, AC DC	000-255-01-037
L104	COIL: electrical, fixed, 4.5 mh, AC DC	000-255-01-037
L201	COIL: electrical, fixed, 250 uh, AC DC	000-255-01-038
L202	COIL: electrical, fixed, 250 uh, AC DC	000-255-01-038
L203	COIL: electrical, fixed, 250 uh, AC DC	000-255-01-038

Ref. Desig.	Description	Singer Part No.
L501	COIL: electrical, fixed, 0.045 uh	000-255-01-160
L502	COIL: electrical, fixed, 0.091 uh	000-255-01-155
L503	COIL: electrical, fixed, 0.091 uh	000-255-01-155
M101	METER: indicating, 200 ma	000-590-01-007
M102	METER: indicating, 100 ma	000-590-01-010
P201	PLUG: electrical, power	000-207-99-002
P301	PLUG: cable	000-275-99-005
Q101	TRANSISTOR: germanium, pnp	000-887-99-004
R101	RESISTOR: fixed, composition, 47 K ohm ± 5%, 2 watt	151-1005-473J
R102	RESISTOR: fixed, composition, 2.2 M ohm ± 10%, 1/2 watt	151-1003-225K
R103	RESISTOR: fixed, composition, 100 K ohm ± 10%, 1/2 watt	151-1003-104K
R104	RESISTOR: fixed, composition, 220 K ohm ± 10%, 1/2 watt	151-1003-224K
R105	RESISTOR: fixed, composition, 1 M ohm ± 10%, 1/2 watt	151-1004-105K
R106	RESISTOR: fixed, composition, 470 K ohm ± 10%, 1/2 watt	151-1003-474K
R107	RESISTOR: fixed, composition, 22 K ohm ± 10%, 1/2 watt	151-1003-223K
R108	RESISTOR: fixed, composition, 33 K ohm ± 10%, 2 watt	151-1005-333K
R109	RESISTOR: fixed, composition, 330 K ohm ± 10%, 1/2 watt	151-1003-334K
R110	RESISTOR: fixed, deposited carbon film, 75 K ohm ± 1%, 1/2 watt	000-730-08-373
R111	RESISTOR: fixed, deposited carbon film, 28.4 K ohm ± 1%, 1/2 watt	000-730-01-054
R112	RESISTOR: fixed, deposited carbon film, 75 K ohm, ± 1%, 1 watt	000-730-17-373
R113	RESISTOR: fixed, deposited carbon film, 28.4 K ohm ± 1%, 1/2 watt	000-730-01-054
R114	RESISTOR: variable linear, composition, 1 K ohm ± 30%, 1/4 watt	000-729-06-002
R115	RESISTOR: fixed, composition, 160 K ohm ± 5%, 1 watt	151-1004-164J
R116	RESISTOR: fixed, composition, 2.7 K ohm ± 5%, 1/2 watt	151-1003-272J
R117	RESISTOR: variable linear, composition, 1 K ohm ± 30%, 1/4 watt	000-729-06-002
R118	RESISTOR: fixed, composition, 150 K ohm ± 5%, 1 watt	151-1004-154J
R119	RESISTOR: fixed, composition, 82 K ohm ± 5%, 1/2 watt	151-1003-823J
R120	RESISTOR: fixed, composition, 56 K ohm ± 5%, 1 watt	151-1004-563J
R121	RESISTOR: fixed, composition, 150 K ohm ± 5%, 1/2 watt	151-1003-154J
R122	RESISTOR: fixed, composition, 680 ohm ± 5%, 1/2 watt	151-1003-681J
R123	RESISTOR: variable linear, composition, 50 K ohm ± 30%, 1/4 watt	000-729-06-004
R124	RESISTOR: fixed, wire wound, 30 K ohm ± 10%, 10 watt	000-731-04-058
R125	RESISTOR: variable, wire wound, 50 K ohm ± 10%, 2 watt	000-733-06-003
R126	RESISTOR: fixed, composition, 100 ohm ± 5%, 1/2 watt	151-1003-101J
R127	RESISTOR: fixed, composition, 47 K ohm ± 5%, 1/2 watt	151-1003-473J
R128	RESISTOR: variable linear, composition, 50 K ohm ± 30%, 1/4 watt	000-729-06-004
R129	RESISTOR: variable, wire wound, 5 K ohm ± 10%, 2 watt	000-733-06-001
R130	RESISTOR: fixed, composition, 560 K ohm ± 5%, 1/2 watt	151-1003-564J
R131	RESISTOR: fixed, wire wound, 8.5 K ohm ± 10%, 10 Watt	000-731-05-045
R132	RESISTOR: fixed, composition, 82 K ohm ± 5%, 2 watt	151-1005-823J
R133	RESISTOR: fixed, composition, 2.7 K ohm ± 5%, 1/2 watt	151-1003-272J
R134	RESISTOR: variable, wire wound, 50 K ohm ± 10%, 2 watt	000-733-06-003
R135	RESISTOR: fixed, composition, 82 K ohm ± 5%, 2 watt	151-1005-823J
R136	RESISTOR: fixed, composition, 47 K ohm ± 5%, 1/2 watt	151-1003-473J
R137	RESISTOR: fixed, composition, 47 K ohm ± 5%, 1/2 watt	151-1003-473J
R138	RESISTOR: fixed, composition, 100 K ohm ± 10%, 1/2 watt	151-1003-104K
R139	RESISTOR: fixed, composition, 390 K ohm ± 5%, 1 watt	151-1004-394J
R140	RESISTOR: variable linear, composition, 50 K ohm ± 30% 1/4 watt	000-729-06-004
R141	RESISTOR: fixed, composition, 180 K ohm ± 5%, 1 watt	151-1004-184J

Ref. Desig.	Description	Singer Part No.
R142	RESISTOR: fixed, composition, 270 ohm ± 10%, 1/2 watt	151-1003-271K
R143	RESISTOR: fixed, composition, 270 ohm ± 10%, 1/2 watt	151-1003-271K
R144	RESISTOR: fixed, composition, 33 K ohm ± 5%, 1 watt	151-1004-333J
R145	RESISTOR: fixed, composition, 100 ohm ± 5%, 1 watt	151-1004-101J
R146	RESISTOR: fixed, composition, 39 ohm ± 5%, 1/2 watt	151-1003-390J
R147	RESISTOR: fixed, composition, 39 ohm ± 5%, 1/2 watt	151-1003-390J
R148	RESISTOR: fixed, composition, 33 K ohm ± 5%, 2 watt	151-1005-333J
R149	RESISTOR: fixed, composition, 39 ohm ± 5%, 1/2 watt	151-1003-390J
R150	RESISTOR: fixed, composition, 39 ohm ± 5%, 1/2 watt	151-1003-390J
R151	RESISTOR: fixed, composition, 33 K ohm ± 5%, 2 watt	151-1005-333J
R152	RESISTOR: fixed, composition, 120 K ohm ± 5%, 1 watt	151-1004-124J
R153	RESISTOR: fixed, composition, 240 K ohm ± 5%, 1 watt	151-1004-244J
R154	RESISTOR: fixed, composition, 100 ohm ± 5%, 2 watt	151-1005-101J
R155	RESISTOR: fixed, deposited carbon film, 33 K ohm ± 1%, 1 watt	000-730-01-091
R156	RESISTOR: fixed, deposited carbon film, 25.5 K ohm ± 1%, 1/2 watt	000-730-08-328
R157	RESISTOR: variable linear, composition, 50 K ohm ± 30%, 1/4 watt	000-729-06-004
R158	RESISTOR: fixed, composition, 220 K ohm ± 10%, 1/2 watt	151-1003-224K
R159	RESISTOR: fixed, deposited carbon film, 6.75 K ohm ± 1%, 1/2 watt	000-730-01-053
R160	RESISTOR: fixed, deposited carbon film, 50 ohm ± 1%, 1/2 watt	000-730-01-501
R161	RESISTOR: fixed, composition, 27 K ohm ± 10%, 2 watt	151-1005-273K
R162	RESISTOR: fixed, composition, 27 K ohm ± 10%, 2 watt	151-1005-273K
R163	RESISTOR: fixed, composition, 1 K ohm ± 10%, 1/2 watt	151-1003-102K
R164	RESISTOR: fixed, wire wound, 12 K ohm ± 10%, 10 watt	000-731-04-048
R165	RESISTOR: fixed, composition, 820 ohm ± 5%, 1/2 watt	151-1003-821J
R166	RESISTOR: fixed, composition, 1.5 K ohm ± 5%, 1/2 watt	151-1003-152J
R167	RESISTOR: fixed, composition, 51 K ohm ± 5%, 1/2 watt	151-1003-513J
R168	RESISTOR: fixed, composition, 51 K ohm ± 5%, 1/2 watt	151-1003-513J
R169	RESISTOR: fixed, composition, 1 K ohm ± 5%, 1 watt	151-1004-102J
R170	RESISTOR: fixed, composition, 200 K ohm ± 5%, 2 watt	151-1005-204J
R171	RESISTOR: fixed, composition, 3 K ohm ± 5%, 1/2 watt	000-728-06-060
R172	RESISTOR: fixed, composition, 680 ohm ± 5%, 1/2 watt	151-1003-681J
R201	RESISTOR: fixed, wire wound, 5 ohm ± 10%, 5 watt	000-731-02-005
R202	RESISTOR: fixed, composition, 820 K ohm ± 5%, 1/2 watt	151-1003-824J
R203	RESISTOR: fixed, composition, 680 ohm ± 10%, 1/2 watt	151-1003-681K
R204	RESISTOR: fixed, composition, 33 ohm ± 5%, 1/2 watt	151-1003-330J
R205	RESISTOR: fixed, composition, 680 ohm ± 10%, 1/2 watt	151-1003-681K
R206	RESISTOR: fixed, composition, 33 ohm ± 5%, 1/2 watt	151-1003-330J
R207	RESISTOR: fixed, composition, 33 ohm ± 5%, 1/2 watt	151-1003-330J
R208	RESISTOR: fixed, composition, 680 ohm ± 10%, 1/2 watt	151-1003-681K
R209	RESISTOR: fixed, composition, 1.2 M ohm ± 5%, 1 watt	151-1003-125J
R210	RESISTOR: fixed, composition, 33 ohm ± 5%, 1/2 watt	151-1003-330J
R211	RESISTOR: fixed, composition, 680 ohm ± 10%, 1/2 watt	151-1003-681K
R212	RESISTOR: fixed, composition, 33 ohm ± 5%, 1/2 watt	151-1003-330J
R213	RESISTOR: fixed, composition, 680 ohm ± 10%, 1/2 watt	151-1003-681K
R214	RESISTOR: fixed, wire wound, 10 K ohm ± 10%, 10 watt	000-731-04-047
R215	RESISTOR: fixed, composition, 10 M ohm ± 5%, 1/2 watt	151-1003-106J
R216	RESISTOR: fixed, composition, 1.2 M ohm ± 5%, 1 watt	151-1004-125J
R217	RESISTOR: fixed, composition, 8.2 M ohm ± 5%, 1/2 watt	151-1003-825J

Ref. Desig.	Description	Singer Part No.
R218	RESISTOR: fixed, deposited carbon film, 604 K ohm ± 1%, 1/2 watt	000-730-08-460
R219	RESISTOR: fixed, composition, 100 K ohm ± 5%, 1/2 watt	151-1003-104J
R220	RESISTOR: fixed, deposited carbon film, 402 K ohm ± 1%, 1/2 watt	000-730-08-443
R221	RESISTOR: fixed, composition, 56 K ohm ± 5%, 2 watt	151-1005-563J
R222	RESISTOR: fixed, composition, 68 K ohm ± 5%, 1/2 watt	151-1003-683J
R223	RESISTOR: fixed, composition, 3.9 M ohm ± 5%, 1/2 watt	151-1003-395J
R224	RESISTOR: fixed, composition, 56 K ohm ± 5%, 1/2 watt	151-1003-563J
R225	RESISTOR: fixed, composition, 100 K ohm ± 5%, 1/2 watt	151-1003-104J
R226	RESISTOR: fixed, deposited carbon film, 287 K ohm ± 1%, 1/2 watt	000-730-08-429
R227	RESISTOR: variable linear, composition, 50 K ohm ± 30% 1/4 watt	000-729-06-004
R228	RESISTOR: fixed, deposited carbon film, 402 K ohm ± 1%, 1/2 watt	000-730-08-443
R229	RESISTOR: fixed, wire wound, 125 ohm ± 10%, 5 watt	000-731-99-008
R230	RESISTOR: fixed, composition, 18 K ohm ± 5%, 1 watt	151-1004-183J
R231	RESISTOR: fixed, composition, 100 K ohm ± 5%, 1/2 watt	151-1003-104J
R232	RESISTOR: fixed, composition, 270 ohm ± 10%, 1 watt	151-1004-271K
R233	RESISTOR: fixed, composition, 33 K ohm ± 10%, 1/2 watt	151-1003-333K
R234	RESISTOR: fixed, composition, 150 K ohm ± 10%, 1/2 watt	151-1003-154K
R235	RESISTOR: fixed, composition, 47 K ohm ± 5%, 1/2 watt	151-1003-473J
R236	RESISTOR: fixed, wire wound, 1.5 ohm ± 3%, 3 watt	556036-010
R301	RESISTOR: fixed, deposited carbon film, 95.3 ohm ± 1%, 1/2 watt	000-730-08-095
R302	RESISTOR: fixed, deposited carbon film, 71.5 ohm ± 1%, 1/2 watt	000-730-08-083
R303	RESISTOR: fixed, deposited carbon film, 95.3 ohm ± 1%, 1/2 watt	000-730-08-095
R304	RESISTOR: fixed, deposited carbon film, 60.4 ohm ± 1%, 1/2 watt	000-730-08-076
R305	RESISTOR: fixed, deposited carbon film, 249 ohm ± 1%, 1/2 watt	000-730-08-135
R306	RESISTOR: fixed, deposited carbon film, 60.4 ohm ± 1%, 1/2 watt	000-730-08-076
R307	RESISTOR: fixed, deposited carbon film, 53.6 ohm ± 1%, 1/2 watt	000-730-08-071
R308	RESISTOR: fixed, deposited carbon film, 787 ohm ± 1%, 1/2 watt	000-730-08-183
R309	RESISTOR: fixed, deposited carbon film, 53.6 ohm ± 1%, 1/2 watt	000-730-08-071
R310	RESISTOR: fixed, deposited carbon film, 53.6 ohm ± 1%, 1/2 watt	000-730-08-071
R311	RESISTOR: fixed, deposited carbon film, 787 ohm ± 1%, 1/2 watt	000-730-08-183
R312	RESISTOR: fixed, deposited carbon film, 26.7 ohm ± 1%, 1/2 watt	000-730-08-042
R313	RESISTOR: fixed, deposited carbon film, 787 ohm ± 1%, 1/2 watt	000-730-08-183
R314	RESISTOR: fixed, deposited carbon film, 53.6 ohm ± 1%, 1/2 watt	000-730-08-071
R401	RESISTOR: fixed, composition, 220 ohm ± 5%, 1/2 watt	151-1003-221J
R402	RESISTOR: fixed, composition, 220 ohm ± 5%, 1/2 watt	151-1003-221J
R403	Determined at the factory	151-1003
R404	RESISTOR: fixed, composition, 82 ohm ± 5%, 1/2 watt	151-1003-820J
R405	RESISTOR: fixed, composition, 82 ohm ± 5%, 1/2 watt	151-1003-820J
R406	Determined at the factory	151-1003-
R407	RESISTOR: fixed, composition, 20 ohm ± 5%, 1/2 watt	151-1003-200J
R408	RESISTOR: fixed, composition, 20 ohm ± 5%, 1/2 watt	151-1003-200J
R409	Determined at the factory	151-1003-
R410	RESISTOR: fixed, composition, 220 ohm ± 5%, 1/2 watt	151-1003-221J
R411	Determined at the factory	151-1003
R412	RESISTOR: fixed, composition, 1 K ohm ± 5%, 1/2 watt	151-1003-102J

Ref. Desig.	Description	Singer Part No.
R413	RESISTOR: fixed, composition, 330 ohm ± 5%, 1/2 watt	151-1003-331J
R414	RESISTOR: fixed, composition, 39 ohm ± 5%, 1/2 watt	151-1003-390J
R415	RESISTOR: fixed, composition, 39 ohm ± 5%, 1/2 watt	151-1003-390J
R416	RESISTOR: fixed, composition, 18 ohm ± 5%, 1/2 watt	151-1003-180J
R417	RESISTOR: fixed, composition, 18 ohm ± 5%, 1/2 watt	151-1003-180J
R418	RESISTOR: fixed, composition, 10 ohm ± 5%, 1/2 watt	151-1003-100J
R419	RESISTOR: fixed, composition, 10 ohm ± 5%, 1/2 watt	151-1003-100J
R420	RESISTOR: fixed, composition, 680 ohm ± 5%, 1/2 watt	151-1003-681J
R421	RESISTOR: fixed, composition, 680 ohm ± 5%, 1/2 watt	151-1003-681J
R422	RESISTOR: fixed, composition, 680 ohm ± 5%, 1/2 watt	151-1003-681J
R423	RESISTOR: fixed, composition, 680 ohm ± 5%, 1/2 watt	151-1003-681J
RT101	LAMP: indicating, 12 volt	000-555-99-008
S101	SWITCH: toggle, double-pole, double throw, 3 position	000-831-99-006
S102	SWITCH: rotary, 1 section, 5 position, nonshorting	000-829-01-011
S103	SWITCH: lever, micro, single pole, double throw, 125 volt	000-841-99-005
S104	SWITCH: rotary, 2 section, 6 position, nonshorting	000-829-01-012
S201	SWITCH: toggle, single pole, single throw	000-831-99-004
S301	SWITCH: lever, 4 pole, double throw	000-835-99-004
S302	SWITCH: lever, 4 pole, double throw	000-835-99-004
S303	SWITCH: lever, 4 pole double throw	000-835-99-004
S304	SWITCH: lever, 4 pole, double throw	000-835-99-004
S305	SWITCH: lever, 4 pole, double throw	000-835-99-004
S306	SWITCH: lever, single pole, double throw	000-841-99-003
S307	SWITCH: lever, single pole, double throw	000-841-99-003
S308	SWITCH: lever, single pole, double throw	000-841-99-003
S309	SWITCH: lever, single pole, double throw	000-841-99-003
S310	SWITCH: lever, single pole, double throw	000-841-99-003
S311	SWITCH: lever, single pole, double throw	000-841-99-003
S312	SWITCH: lever, single pole, double throw	000-841-99-003
S313	SWITCH: lever, single pole, double throw	000-841-99-003
T101	TRANSFORMER: audio	000-885-01-008
T201	TRANSFORMER: power	000-885-01-004
T401	TRANSFORMER ASSEMBLY: band 1, 50-170 kc	000-255-01-165
T402	TRANSFORMER ASSEMBLY: band 2, 165-560 kc	000-255-01-166
T403	TRANSFORMER ASSEMBLY: band 3, 530-1800 kc	000-255-01-167
T404	TRANSFORMER ASSEMBLY: band 4, 1.75-6.0 mc	000-255-01-168
T405	TRANSFORMER ASSEMBLY: band 5, 5.8-19.2 mc	000-255-01-169
T406	TRANSFORMER ASSEMBLY: band 6, 19.0-65 mc	132-0015-001
T407	TRANSFORMER ASSEMBLY: band 1, 50-170 kc	000-255-01-138
T408	TRANSFORMER ASSEMBLY: band 2, 165-560 kc	000-255-01-139
T409	TRANSFORMER ASSEMBLY: band 3, 530-1800 kc	000-255-01-140
T410	TRANSFORMER ASSEMBLY: band 4, 1.75-6.0 mc	000-255-01-141
T411	TRANSFORMER ASSEMBLY: band 5, 5-8-19.2 mc	000-255-01-142
T412	TRANSFORMER ASSEMBLY: band 6, 19.0-65 mc	132-0014-001
V101	TUBE: electron, 6AW8A	556027-079
V102	TUBE: electron, 12AT7	556027-017
V103	TUBE: electron, 12AT7	556027-017
V104	TUBE: electron, 12AT7-WA	000-897-02-033
V105	TUBE: electron, 6AW8A	556027-079
V106	TUBE: electron, 6AW8A	556027-079
V107	TUBE: electron, 12AT7-WA	000-897-02-033
V108	TUBE: electron, 12B4A	000-897-02-054

Ref. Desig.	Description	Singer Part No.
V109	TUBE: electron, 6CL6	556027-096
V110	TUBE: electron, 6CL6	556027-096
V201	TUBE: electron, 12B4A	000-897-02-039
V202	TUBE: electron, 12B4A	000-879-02-039
V203	TUBE: electron, 12B4A	000-897-02-039
V204	TUBE: electron, 12B4A	000-897-02-039
V205	TUBE: electron, 12B4A	000-897-02-039
V206	TUBE: electron, 6AW8A	556027-079
V207	TUBE: electron, 12B4A	000-897-02-039
V208	TUBE: electron, 6AW8A	556027-079
V209	TUBE: electron, 5651	556027-048
Y101	CRYSTAL: 100 kc	000-358-01-011
Y102	CRYSTAL: 1000 kc	000-359-01-010

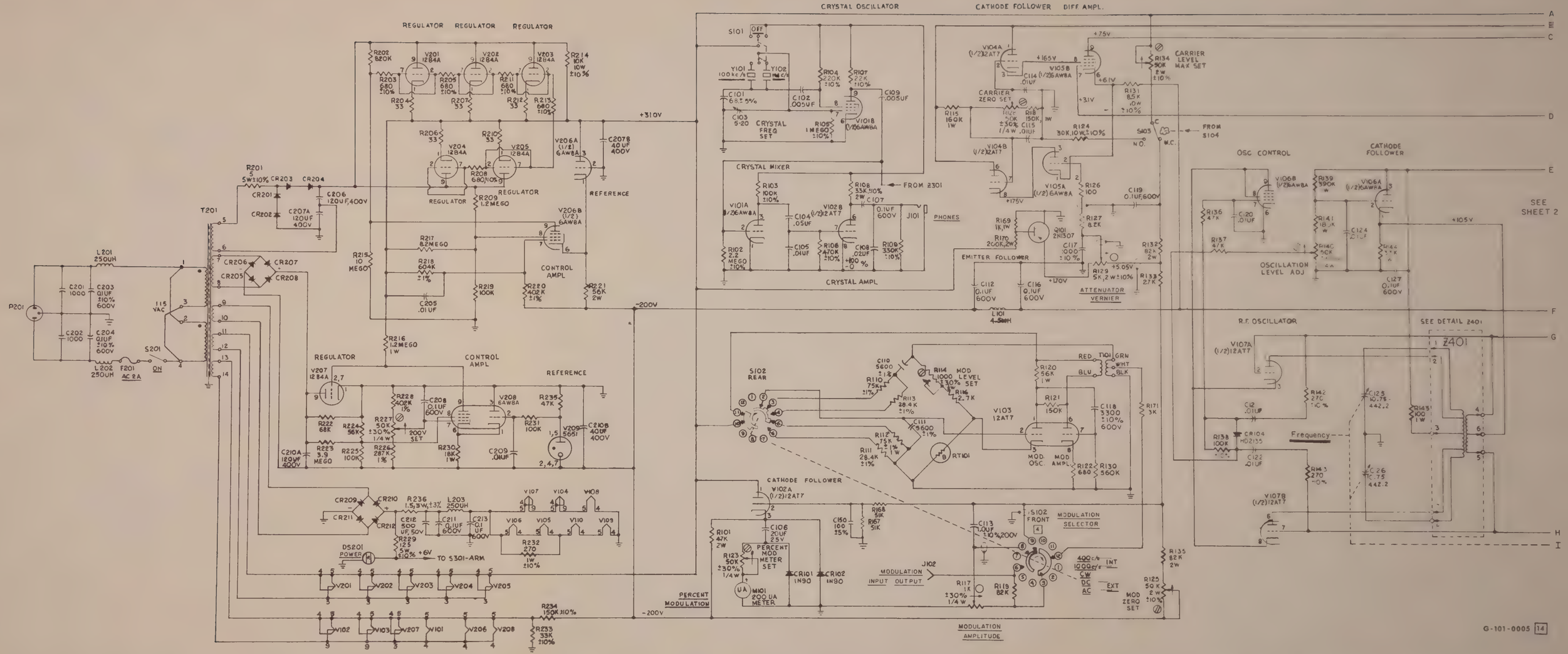


Figure 7-1. Schematic Diagram, Signal Generator Model SG-8 (Sheet 1 of 2)

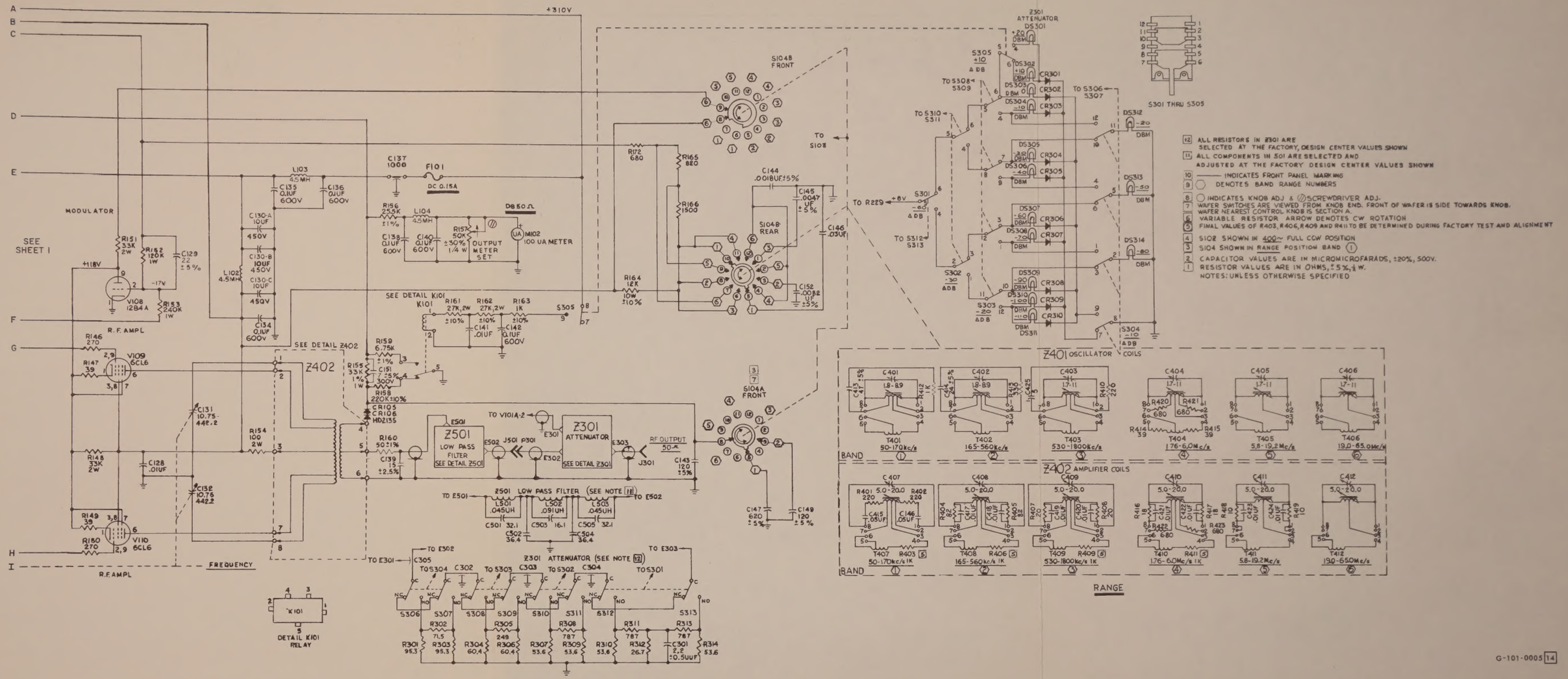
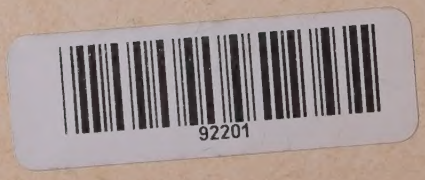


Figure 7-1. Schematic Diagram, Signal Generator Model SG-8 (Sheet 2 of 2)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